CO_2SMO PLUS!

RESPIRATORY PROFILE MONITOR

User's Manual

Model 8100

October 10, 1997

Catalog No. 6758-23-02

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Revision History

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Thank you . . .

. . . for selecting the *CO_2SMO Plus!* Respiratory Profile Monitor. You are the operator of one of the most advanced, state-of-the-art respiratory instruments available today. Our engineering staff, in collaboration with the medical community, has invested considerable effort to produce a highly accurate and extremely versatile instrument for respiratory monitoring. While we expect that the *CO_2SMO Plus!* will meet your specific needs, we nonetheless are interested in receiving any comments you may have.

Please review this manual prior to using the monitor. We are available to help you with servicing or applications questions. You may call toll-free at 1-800-243-3444. In Connecticut, call collect at (203) 265-7701.

Sincerely,

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Section 1 *General Description*

Through the combination of capnography, airway flow and pressure, and pulse oximetry, the *CO_2SMO Plus!* provides the clinician with a respiratory profile of the patient. This includes information that was previously difficult to obtain continuously at the bedside, such as CO_2 production (Vco_2) and deadspace parameters, as well as conventional capnography, pulse oximetry, and respiratory mechanics. The continuous respiratory profile provided by the *CO_2SMO Plus!* provides the clinician with immediate feedback that allows precise and efficient patient/ventilator management.

Indication for use

The *CO_2SMO Plus!* is intended to be used for monitoring end tidal CO_2, respiration rate, functional oxygen saturation, pulse rate and respiratory mechanics in monitoring environments such as ventilatory support, emergency and anesthesia. *CO_2SMO Plus!* is designed to monitor adult, pediatric and neonatal patients. *CO_2SMO Plus!* is not intended for any other purposes.

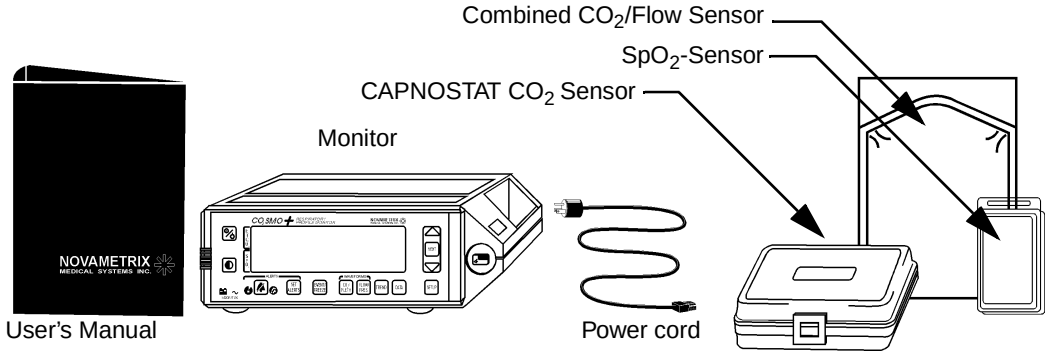
NOTE

Components of this product and its associated accessories which have patient contact are free of latex.

Gas compositions other than those selected in the SETUP screen can influence CO_2 and flow measurement.

Unpacking

The box that your *CO_2SMO Plus!* was shipped in should contain the items shown below. Please contact us at 1-800-243-3444, or contact your local sales representative if any items are missing or damaged, or to order additional accessories.

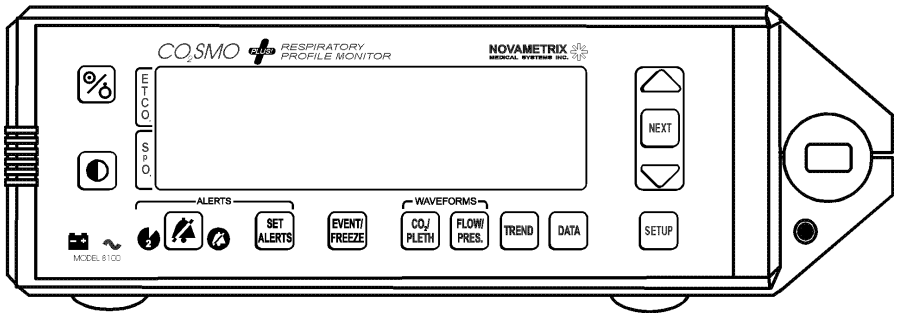


Operational Overview

Parameters Measured

The *CO_2SMO Plus!* measures and calculates various respiratory parameters for patient/ventilator management. Refer to "Monitoring" on page 47 for a complete parameters list.

Front Panel Controls and Indicators



Controls

or *Power Key*

Press the POWER key to place the unit into operate mode (ON) or to place the unit into standby (OFF). There are four states of the unit:

- No AC Power, power icon ∿ off, not in operate mode

  In this condition the AC switch is off, or the power cord is not plugged into an AC outlet, or the outlet is not powered. No monitoring may occur in this state. Battery is not being charged.

- AC Power, power icon ∿ on, not in operate mode (standby)*

  In this condition the unit may be placed into operate mode by pressing the key. Battery is charging in this mode.

- AC Power, power icon ∿ on, in operate mode

  In this condition the unit is in operating mode and the battery is being charged.

- Battery power, power icon ∿ off, battery is not being charged

  In this condition the unit is in the operating mode and the battery is not being charged.

When the monitor powers up a self test is performed in which all indicators will temporarily illuminate and the monitor will emit a short beep. Following the self test the monitor will display:

"ERASE STORED TRENDS?
YES: △ NO: ▽"

*The monitor must be in "stand-by" mode in order for the CAPNOSTAT CO_2 sensor to remain heated when the monitor is off.

If the ⌃ or ⌄ key is not pressed within five seconds, trends will be retained. The monitor is now ready for operation.

Contrast

Press or hold to adjust the display's contrast for different up/down viewing angles.

Alert Silence

Press for 2 minute silence (audible alerts muted for two minutes). The 2 icon will illuminate for the duration of the two minute silence. Press again to cancel.

Press and hold for 3 seconds to disable audible alerts, and the icon will flash. Press and hold again to cancel.

Press to acknowledge a latched alert.

If preconfigured not to allow the audio off function, the key will not disable the audible alerts when pressed (the two minute silence is still active).

Set Alert Limits

Press to set alert limits manually, or hold to set automatically. Press again to accept the displayed limits and return to the previous screen. For more detailed information on setting alert limits see "Setting Alert Limits" on page 80.

Event/Freeze

Press the EVENT/ FREEZE key to freeze the waveforms and loops for sixty seconds. An EVENT MARKER with time and date will appear in the message center for three seconds followed by "WAVEFORM FROZEN UNFREEZE: PRESS EVENT KEY". To resume normal display press EVENT/ FREEZE again, otherwise the waveform will resume again in 60 seconds.

Pressing this key when viewing the DATA entry screen allows you to enter the patient's $PaCO_2$ for calculation of Vd/Vt phy, Vd phy and Vd alv.

CO_2 Waveform/Plethysmogram

Press to switch waveform display between capnogram and capnogram with plethysmogram.

Flow/Pressure Waveforms

Press to switch waveform display between flow and pressure waveforms or loops, or flow and volume waveforms and loops (flow vs. volume and volume vs. pressure) display.

Trend

Press to switch between trend screens.

DATA

Data Screen

Press to switch between data screens (numeric values only), and data entry screen (to enter weight and $PaCO_2$ - see “Data Screens” on page 56 for details).

SETUP

Setup/Configuration

Press to display the SETUP screen, or hold for three seconds to display the CONFIGURATION screen (for advanced settings). Press again to accept the displayed settings and return to the previous screen. Refer to “Setup and Configuration Settings” on page 16.

NEXT

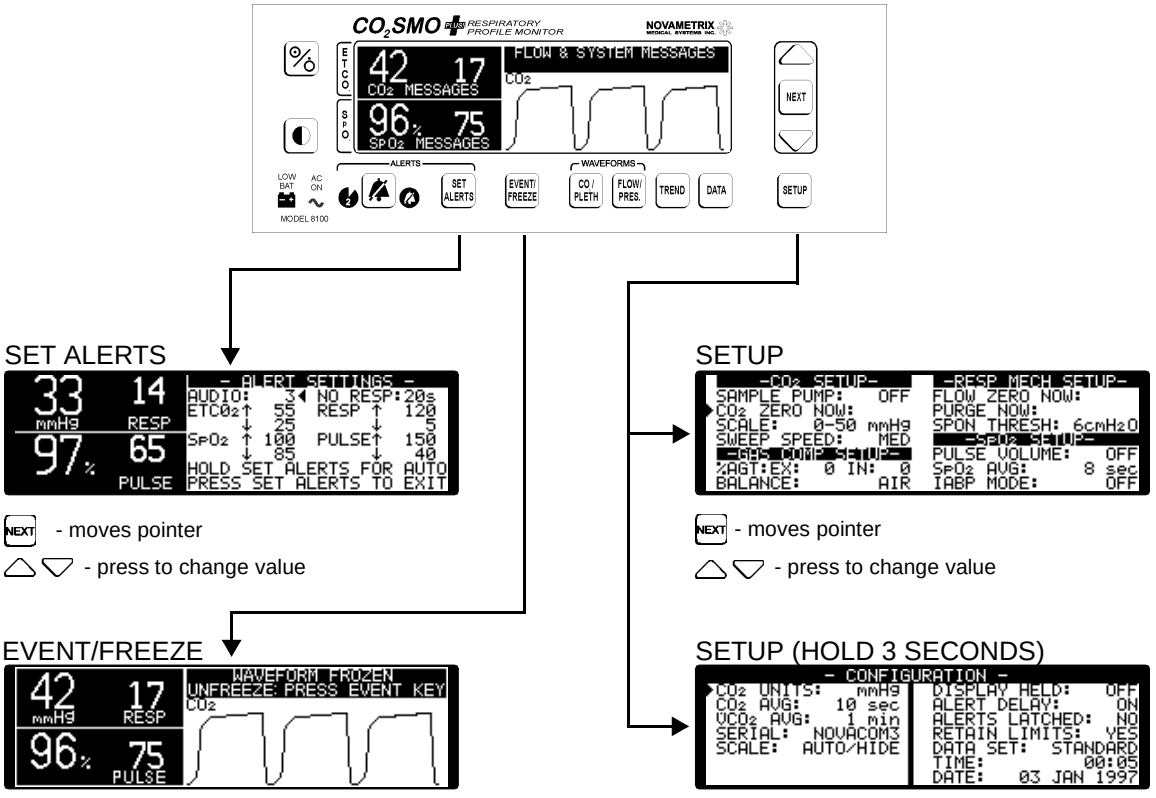
Adjustment Keys

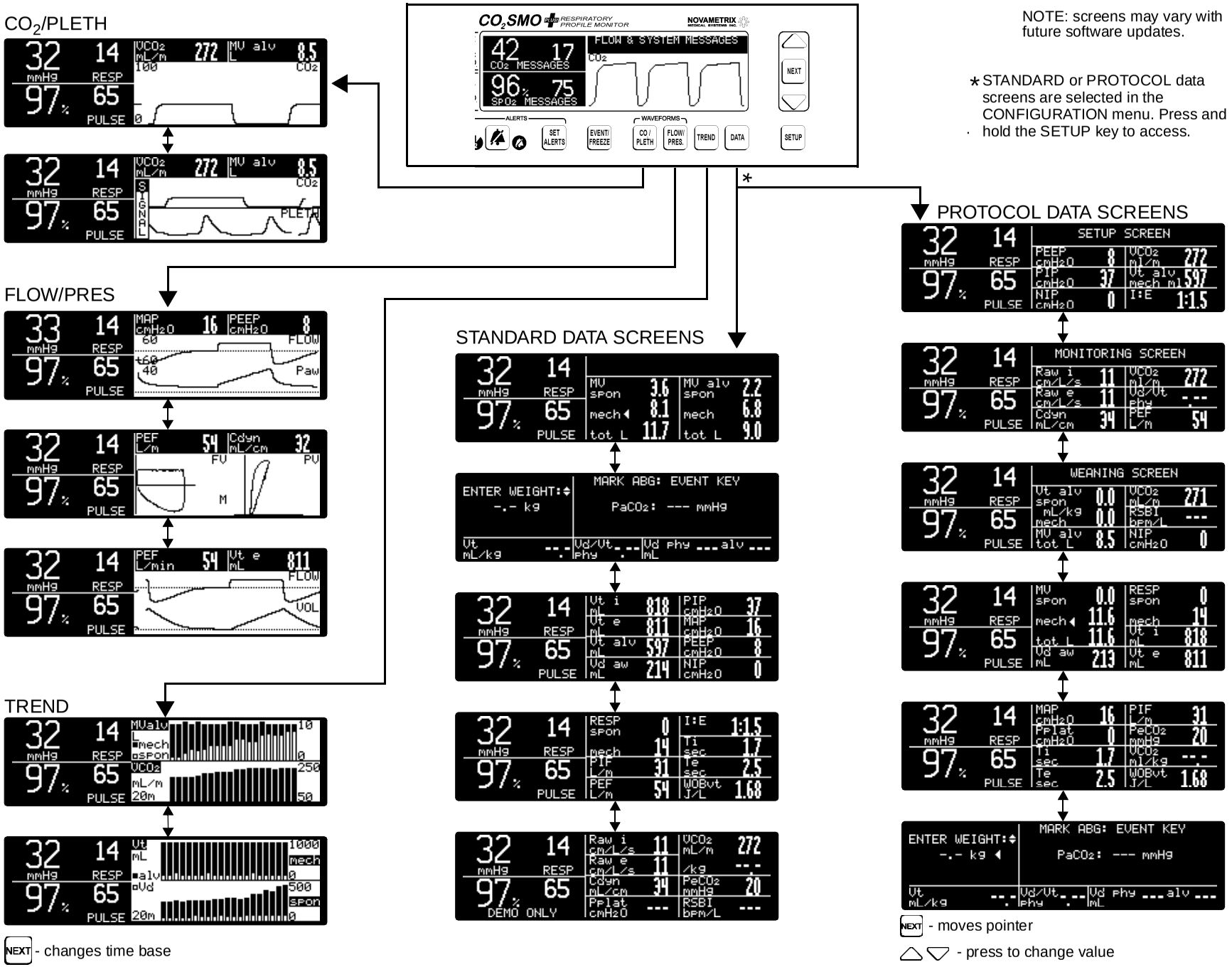
Press NEXT to select different parameters in SETUP, CONFIGURATION, SET ALERTS or DATA ENTRY screen. Press △ and ▽ to change value or state of the currently selected parameter.

The NEXT key is also used to:

- Select different time bases on the Trend screens (see “Trend” on page 3)
- Rescale various waveforms if scaling is set to manual (see “Setup and Configuration Settings” on page 16).

The △ and ▽ keys are also used to respond to monitor prompts such as “ERASE STORED TRENDS? YES: △ NO: ▽.”




CO2SMO Plus RESPIRATORY PROFILE MONITOR
NOVAMETRIX MEDICAL SYSTEMS INC.
FLOW & SYSTEM MESSAGES
CO2 MESSAGES
SPO2 MESSAGES
NEXT
ALERTS
SET ALERTS
EVENT/ FREEZE
WAVEFORMS
CO2/ PLETH
FLOW/ PRES.
TREND
DATA
SETUP
NOTE: screens may vary with future software updates.
* STANDARD or PROTOCOL data screens are selected in the CONFIGURATION menu. Press and hold the SETUP key to access.
CO2/PLETH
FLOW/PRES
TREND
STANDARD DATA SCREENS
PROTOCOL DATA SCREENS
SETUP SCREEN
MONITORING SCREEN
WEANING SCREEN
ENTER WEIGHT:
MARK ABG: EVENT KEY
PaCO2: --- mmHg
DEMO ONLY
NEXT - changes time base
NEXT - moves pointer
- press to change value

Indicators

Battery Alert Icon

Illuminates when the unit is on battery power and the battery charge is critically low. When battery is near exhaustion an audible alert will sound and “BATTERY VERY LOW PLUG IN AC POWER” will appear in the display screen. Refer to “AC/Battery Operation” on page 15 for information on connecting AC power and charging the battery.

AC Power Indicator Icon

Illuminates when the monitor is connected to an AC power source and the rear panel power switch is ON “ | ”. In this condition the internal battery is charging.

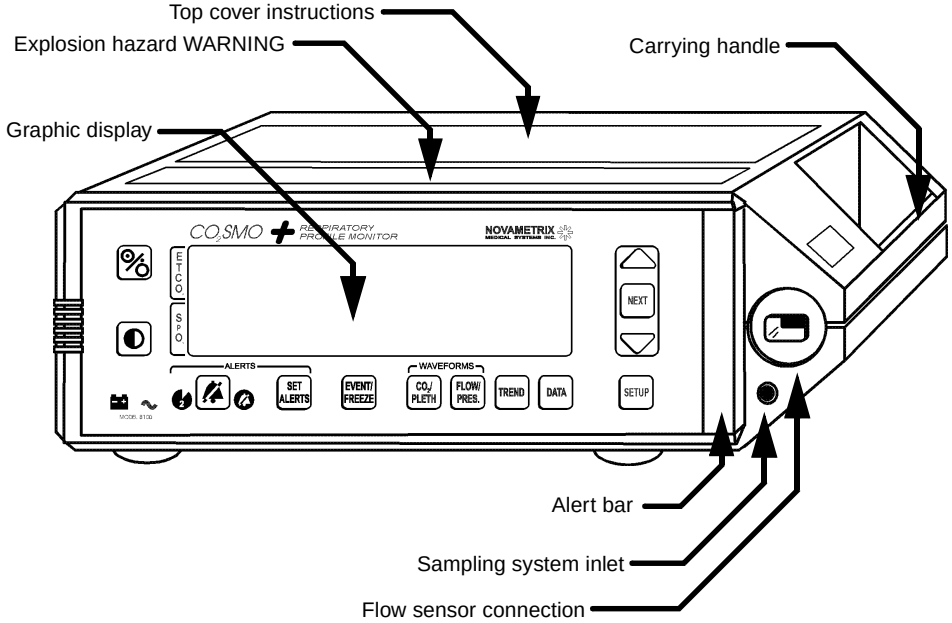
Two Minute Silence Icon

Illuminates when the two minute silence is active.

Audible Alert Disabled Icon

Flashes when audible alerts have been disabled.

Miscellaneous



Graphic Display

Graphic blue/white 240 X 64 pixel dot matrix display.

Alert Bar

Flashes red when alert conditions are detected. When ALERTS LATCHED in the SYSTEM CONFIGURATION is set to ON, the alert bar is latched. This means that when an alert is active, the alert bar will flash even if the condition that caused the alert has been corrected. To reset the latched alert bar press, the key.

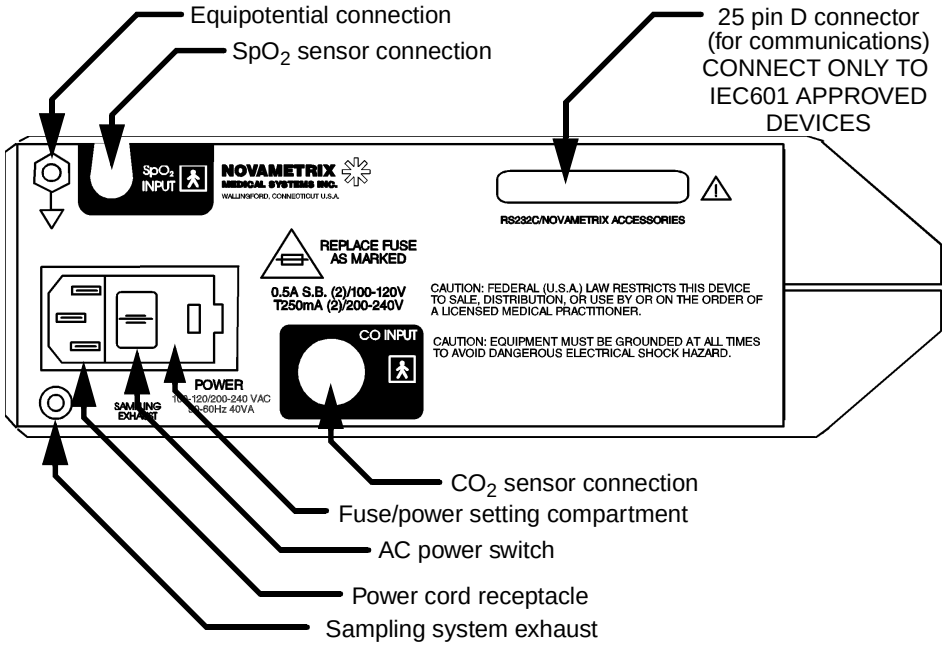
Sampling System Input

Input connection for sampling system tubing. See “Sampling Adapter” on page 30 for more information.

Flow Sensor Connection

Connection for flow sensors. See “Sensors and Patient Connections” on page 23 and “Monitoring Flow (Respiratory Mechanics) Separately” on page 28 for more information.

Rear Panel Connections and Labeling


Equipotential connection
SpO2 sensor connection
25 pin D connector (for communications) CONNECT ONLY TO IEC601 APPROVED DEVICES
SpO2 INPUT
NOVAMETRIX MEDICAL SYSTEMS INC.
WALLINGFORD, CONNECTICUT U.S.A.
RS232C/NOVAMETRIX ACCESSORIES
REPLACE FUSE AS MARKED
0.5A S.B. (2)/100-120V
T250mA (2)/200-240V
CAUTION: FEDERAL (U.S.A.) LAW RESTRICTS THIS DEVICE TO SALE, DISTRIBUTION, OR USE BY OR ON THE ORDER OF A LICENSED MEDICAL PRACTITIONER.
CO INPUT
CAUTION: EQUIPMENT MUST BE GROUNDED AT ALL TIMES TO AVOID DANGEROUS ELECTRICAL SHOCK HAZARD.
POWER
SAMPLING EXHAUST
CO2 sensor connection
Fuse/power setting compartment
AC power switch
Power cord receptacle
Sampling system exhaust

	Equipotentiality: Connection to monitor's chassis
	Patient isolation: Identifies connection as type BF
	Attention: Consult manual for detailed information
250V	Mains fuse rating for replacement fuses
	AC mains switch " | " ON-connection to mains; "O" OFF-disconnection from mains
	Recyclable item. This symbol is found on the internal battery and should not concern the common user. Refer to qualified service personnel when battery replacement is required.
	Separate collection. Appropriate steps must be taken to ensure that spent batteries are collected separately when disposed of. This symbol is found on the internal battery and should not concern the common user. Refer to qualified service personnel when battery replacement is required.
Pb	Indicates heavy metal content, specifically lead. This symbol is found on the internal battery and the monitor enclosure and should not concern the common user. Refer to qualified service personnel when battery replacement is required.

Principle of operation

CO_2

CO_2SMO Plus! uses the CAPNOSTAT CO_2 sensor to measure CO_2 by using the infrared absorbtion technique, which has endured and evolved in the clinical setting for over two decades and remains the most popular and versatile technique today.

The principle is based on the fact that CO_2 molecules absorb infrared (IR) light energy of specific wavelengths, with the amount of energy absorbed being directly related to the CO_2 concentration. When an IR beam is passed through a gas sample containing CO_2, the electronic signal from the photodetector (which measures the remaining light energy) can be obtained. This signal is then compared to the energy of the IR source and calibrated to accurately reflect CO_2 concentration in the sample. To calibrate, the photodetector's response to a known concentration of CO_2 is stored at the factory in the monitor's memory. A reference channel accounts for optical changes in the sensor, allowing the system to remain in calibration without user intervention.

Respiration Rate

The respiration rate is calculated from the flow signal generated whenever a flow or combined CO_2/flow sensor is connected to the *CO_2SMO Plus!*. If a flow or combined CO_2/flow sensor is not connected, and a CAPNOSTAT CO_2 sensor is connected, then the respiration rate is calculated from the CAPNOSTAT CO_2 sensor signal. In the event that there is no flow, CO_2/flow, or CAPNOSTAT CO_2 sensor connected, the respiratory rate will not be calculated.

SpO_2

The *CO_2SMO Plus!* determines oxygen saturation using sensors that contain red and infrared (660 and 940 nanometer) light sources, called light emitting diodes (LEDs). The light energy from each LED is beamed through a tissue sample—a pulsating vascular bed such as the patient's finger or toe. The remaining light energy not absorbed by the tissue sample reaches a photodiode light receptor in the sensor. Oxygen saturated blood absorbs different amounts of light at each wavelength as compared to desaturated blood. Therefore, the amount of light absorbed by the blood in each pulse can be used to calculate oxygen saturation.

The *CO_2SMO Plus!* is calibrated to display "functional" saturation. This differs from the "fractional" saturation value displayed by most co-oximeters. Functional saturation is defined as:

$$\text{Functional Saturation} = \frac{HbO_2}{100 - (COHb + METHb)}$$

HbO_2 = Fractional Oxyhemoglobin
COHb = Carboxyhemoglobin
METHb = Methemoglobin

This can be considered to represent the amount of oxyhemoglobin as a percentage of the hemoglobin that can be oxygenated. Dysfunctional hemoglobins (COHb and METHb) are not included in the measurement of functional saturation.

Pulse Rate is calculated by measuring the time interval between peaks of the infrared light waveform. The inverse of this measurement is displayed as pulse rate.

The oxygen saturation and pulse rate values are updated once each second. Presence of a pulse is indicated visibly by a plethysmogram graphic display and audibly by a “beep.”

The *CO_2SMO Plus!* must be used in conjunction with SuperBright™ Sensors. See “Accessories” for a list of available sensors and accessories.

Flow

Flow measurements in the *CO_2SMO Plus!* are made by a fixed orifice differential pressure pneumotachometer. Respired gas flowing through the flow sensor causes a small pressure drop across the two tubes connected to the sensor. This pressure drop is transmitted through the tubing to a differential pressure transducer located inside the monitor, and is correlated to flow according to the factory stored calibration. User calibration is not required due to the ability of the plastic injection mold to repeatedly produce precision flow sensors. The pressure transducer is automatically “zeroed” to correct for changes in ambient temperature and electronics.

The *CO_2SMO Plus!* system software compensations allow accurate flow and volume measurements in the presence of high oxygen concentrations, anesthetic gases and helium-oxygen mixtures. When compensated, gas density and viscosity effects do not cause significant errors in flow measurement.

For maximum flow sensor performance:

(1) keep the pressure sensing ports oriented upward;

(2) keep the sensor clear of accumulations by proper breathing circuit maintenance;

(3) confirm that the gas compositions entered correspond to ‘best’ known values (refer to “Setup and Configuration Settings” on page 16).

Section 2 *Safety*

The *CO_2SMO Plus!* monitor is electrically isolated. Patient leakage current flowing from the instrument to ground is limited to less than 100 uA at 120/220 VAC, 50-60Hz.

For maximum patient and operator safety, you must follow the following warnings and cautions.

WARNINGS

Indicates a potentially harmful condition that can lead to personal injury.

- Explosion Hazard: *DO NOT* use *CO_2SMO Plus!* in the presence of flammable anesthetics. Use of this instrument in such an environment may present an explosion hazard.
- Electrical Shock Hazard: Always turn *CO_2SMO Plus!* off and remove the line cord before cleaning it. Refer servicing to qualified service personnel.
- Never sterilize or immerse the monitor in liquids.
- Do not operate *CO_2SMO Plus!* when it is wet due to spills or condensation.
- Do not operate *CO_2SMO Plus!* if it appears to have been dropped or damaged.
- Failure of Operation: If the monitor fails to respond as described, do not use it until the situation has been corrected by qualified personnel.
- The *CO_2SMO Plus!* is not intended to be used as a primary diagnostic apnea monitor and/or recording device.
- Patient Safety: Care should be exercised to assure continued peripheral perfusion distal to the SpO_2 sensor site after application.
- Inspect the SpO_2 sensor site often for adequate circulation - at least once every four hours. When applying sensors take note of patient's physiological condition. For example, burn patients may exhibit more sensitivity to heat and pressure and therefore additional consideration such as more frequent site checks may be appropriate.
- Data Validity: As with all pulse oximeters, inaccurate SpO_2 and Pulse Rate values may be caused by:
  - Incorrect application or use of sensor;
  - Significant levels of dysfunctional hemoglobin; carboxyhemoglobin or methemoglobin;
  - Significant levels of indocyanine green, methylene blue, or other intravascular dyes;
  - Exposure to excessive illumination such as surgical lamps-especially those with a xenon light source, or direct sunlight;
  - Excessive patient movement;
  - Venous pulsations;
  - Electrosurgical interference.
- A "NO RESPIRATION" alert is not generated when both the CAPNOSTAT CO_2 sensor and the flow sensor are disconnected from the *CO_2SMO Plus!*.
- The *CO_2SMO Plus!* automatically identifies the type of flow sensor (neonatal or pediatric/adult) when it is connected. If a flow sensor identification message is not displayed when a flow or CO_2/flow sensor is first connected, DO NOT use the sensor. If the condition persists, refer the monitor to qualified service personnel.

- Periodically check the flow sensor and tubing for excessive moisture or secretion build up. Although the *CO_2SMO Plus!* automatically purges the lines, excessive moisture or secretions may still remain.
- While using the flow sensor, a system leak, such as that caused by uncuffed endotracheal tubes or a damaged flow sensor may significantly effect flow related readings. These include flow, pressure, dead space, CO_2 production and other respiratory mechanics parameters.
- Connect the line cord to a grounded hospital-grade outlet. *CO_2SMO Plus!* should be connected to the same electrical circuit as other equipment in use on the patient. Outlets of the same circuit can be identified by the hospital's engineering department.
- The *CO_2SMO Plus!* has no protection against the ingress of water.

CAUTIONS

Indicates a condition that may lead to equipment damage or malfunction.

- Do not operate *CO_2SMO Plus!* when it is wet due to spills or condensation.
- Do not operate *CO_2SMO Plus!* if it appears to have been dropped or damaged.
- Keep *CO_2SMO Plus!* and its accessories clean.
- Never sterilize or immerse the monitor in liquids.
- Do not sterilize or immerse sensors except as directed in this manual.
- Do not apply excessive tension to any sensor cable or pneumatic tubing.
- Do not store the monitor or sensors at temperatures less than 14°F (-10°C) or above 131°F (55°C).
- Do not operate the monitor or sensors at temperatures below 50°F (10°C) or above 104°F (40°C).
- Federal (U.S.A.) law restricts this device to sale, distribution, or use by or on the order of a licensed medical practitioner.
- DO NOT attach an SpO_2 sensor distal to a blood pressure cuff. Valid data CANNOT be processed when the cuff is inflated. Attach the sensor to the limb opposite to the site used for the blood pressure cuff.
- Excessive moisture in the flow sensor may affect the accuracy of the flow measurement.
- To avoid the effects of excessive moisture in the measurement circuit, insert the flow sensor in the ventilator circuit with the tubes upright (as shown by arrows). The striped tube is positioned closest to the patient. Improper placement will result in erroneous data.
- It is recommended that the CO_2/Flow sensor be removed from the circuit whenever an aerosolized medication is delivered. This is due to the increased viscosity of the medications which may contaminate the sensor windows, causing the sensor to fail prematurely.
- In case of interference with our equipment or another manufacturer's equipment, notify your Novametrix representative.

NOTES

Indicates points of particular interest or emphasis for more efficient or convenient operation.

- Components of this product and its associated accessories which have patient contact are free of latex.
- As with all flow measuring devices, adverse conditions may affect the accuracy of the flow measurement. See page 10 for a discussion of flow measurement.
- If CO_2 is being measured while not using a flow sensor, certain rebreathing circuits, or the presence of artifacts such as cardiogenic oscillations, may cause *CO_2SMO Plus!* to react to non-respiratory CO_2 fluctuations as if they were breaths. This condition affects only the numerical displays; the capnogram display continues to provide an accurate picture of the CO_2 waveform.

- When a new CAPNOSTAT CO_2 sensor is attached to the monitor, or is moved from one monitor to another, it must be initialized before use. The CAPNOSTAT CO_2 sensor does not have to be initialized again as long as it is used with the same monitor.
- If you use the *CO_2SMO Plus!* for transport or if you drastically change the orientation of the *CO_2SMO Plus!*, the flow sensor must be manually re-zeroed. See page 32 for more information on the flow sensor zero procedure.
- After the life cycle of our equipment and all accessories has been met, disposal of the equipment should be accomplished following the national requirements. Contact the local Novametrix representative for questions concerning disposal.

[This page intentionally blank.]

Section 3 Preparation for Use

AC/Battery Operation

Press the POWER key to place the unit into operate mode (ON) or to place the unit into standby (OFF). The status of the unit is dependent upon both the key and the power source:

- No AC Power, power icon off, not in operate mode

  In this condition the AC switch is off, or the power cord is not plugged into an AC outlet, or the outlet is not powered. No monitoring may occur in this state. Battery is not being charged.

- AC Power, power icon on, not in operate mode (standby)*

  In this condition the unit may be placed into operate mode by pressing the key. Battery is charging in this mode.

- AC Power, power icon on, in operate mode

  In this condition the unit is in operating mode and the battery is being charged.

- Battery power, power icon off, battery is not being charged

  In this condition the unit is in the operating mode and the battery is not being charged.

The *CO_2SMO Plus!* uses battery power when the line cord is disconnected or the rear panel power switch is OFF (O). The monitor can operate for up to two hours while powered from its internal battery (fully charged). The battery is charging only when the monitor is connected to AC power, the rear panel power switch is ON (|), and the front panel icon is green.

NOTE

Excessive alerting reduces battery life when operating on battery power.

When the monitor is operating on battery power, and the battery is sufficiently charged, the battery icon on the front panel will be off and a battery icon will appear on the display. The battery level is reflected on the display (by a different icon) by "shading" inside the battery icon (for example, battery fully charged: , battery low:). Should the battery become exhausted the front panel icon will begin flashing red; the monitor will sound an audible alert, then when the battery is depleted turn itself off. Reconnect the monitor to the AC line to recharge the battery. The battery will be fully recharged in 12 hours.

Long Term Storage

If the monitor has not been used or powered by AC mains for an extended time† (3 months or more) allow the battery to charge for 12 hours before use. The monitor may not power up on battery power if the

*The monitor must be in "stand-by" mode in order for the CAPNOSTAT CO_2 sensor to remain heated when the monitor is off.

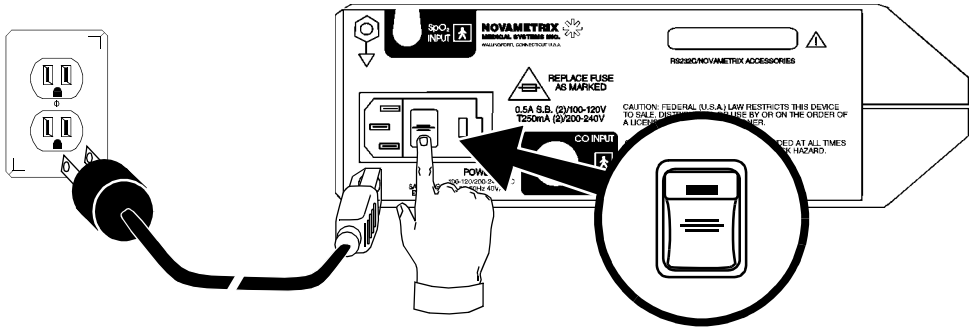
†The internal battery may slowly discharge over long periods of non-use.

battery is not sufficiently charged. Allow the battery to charge for 12 hours before initial use; refer to the following diagram for charging instructions.

NOTE

When the battery is low (blinking on front panel) the monitor will not zero the flow sensor. This may cause the calculations based on the flow signal to drift outside of normal performance specifications. Connect to AC power as soon as possible.

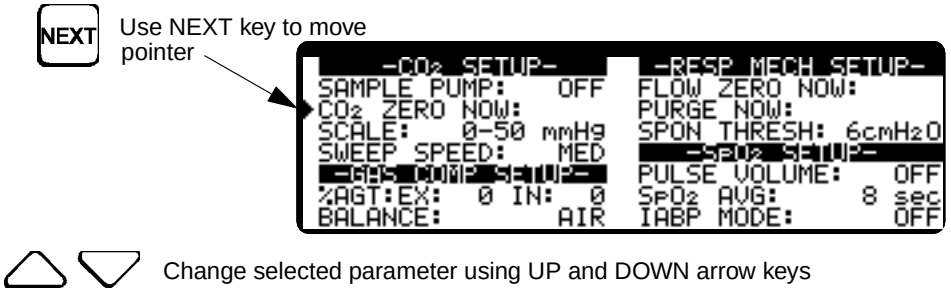
To charge the battery, connect the line cord to an AC source and set the rear panel power switch ON (|). Check that the front panel icon is green. Charge the battery for 12 hours.



Setup and Configuration Settings

The SETUP and CONFIGURATION screens can be programmed by the user to customize the *CO_2SMO Plus!*. The SETUP screen also allows a CO_2 adapter zero, a flow sensor zero, or a flow sensor purge to be performed upon request. To access the SETUP screen press the SETUP key. Use the NEXT key to move the flashing pointer to the parameter to be set, then adjust using the △ and ▽ arrow keys. Any changes made will be retained when the monitor is turned off.

NOTE: To reset the monitor to its factory default settings: with the monitor off, press and hold the SET ALERTS key while pressing the % key to turn the monitor on.



SETUP options are described below:

Parameter		Description	Factory Default
CO_2 Setup:	SAMPLE PUMP	Turns the CO_2 sampling pump ON/OFF (for using sidestream sampling adapter)	OFF
	CO2 ZERO NOW	Press △ arrow key to enter the adapter zero menu	Blank
	SCALE	Choose a 0-50, 0-75 or 0-100 scale for the CO_2 waveform display	0-50
	SWEEP SPEED	Choose a sweep speed for the CO_2 waveform: slow, medium, or fast (the flow and pressure waveforms will also be set to this selected sweep speed)	Medium
Gas Comp. Setup:	%AGT (Anesthetic Agent Concentration)	Choose the closest setting to true gases in the breathing circuit (see below for details). Adjust expired (EX) and inspired (IN) values in increments of 1% from 0%-20%	0, 0
	BALANCE	Select balance: Air, N_2O/O_2, >60% O_2, or Heliox (60% He, 35% O_2)	Air
Resp. Mech Setup:	FLOW ZERO NOW	Press △ arrow key to zero the flow sensor lines	Blank
	PURGE NOW	Press △ arrow key to purge the flow sensor lines	Blank
	SPON THRESH	Adjust pressure threshold which *CO_2SMO Plus!* uses to identify spontaneous or mechanical breaths (from 0-60 cmH_2O in increments of 1 cmH_2O)	6 cm H_2O
SpO_2 Setup:	PULSE VOLUME	Choose OFF or ON with a volume level of 1 through 10.	OFF
	SPO2 AVG	Choose 2 sec or 8 sec SpO_2 averaging	8 sec
	IABP MODE	OFF or ON (see below for explanation)	OFF

GAS COMP: Use this setting to enter the gas composition in order to compensate the flow measurement for gas density. Any setting other than the default (0% agent, balance air) will cause the monitor to display "GAS COMP" on the screen below the respiration rate value (the RESP label moves above the respiration rate value).

Selected Balance	Expired Compensation values (%) for selected balance				
	CO_2	O_2	N_2	N_2O	He
Air	5	17	78	0	0
N_2O/O_2	5	35	0	60	0
>60% O_2	5	75	20	0	0
Heliox	5	35	0	0	60

Assumed inspired concentrations based on selected expired concentrations:

- Inspired CO_2=0
- Inspired O_2=Expired setting + 4 Volume %
- Inspired N_2=Expired setting
- Inspired N_2O=Expired setting + 1 Volume %
- Inspired He=Expired setting
- Anesthetic agent (AGT): When the expired agent compensation is adjusted, the inspired value will automatically change to match the expired setting. If the inspired value is then adjusted, it will change independently from the expired value until the next time the expired value is adjusted.

IABP MODE: *CO_2SMO Plus!* uses advanced SpO_2 signal processing algorithms to distinguish valid pulsatile signals from signals generated by motion or other artifact. Motion artifact, very common in all but heavily sedated patients, can swamp the true pulsatile signal or distort it enough to produce significant errors in the SpO_2 and Pulse Rate calculations. The validator algorithms reject distorted plethysmographic signals or those that lack a regular rhythmic pattern; therefore, only valid (pulsatile) signals are allowed to affect the monitor's SpO_2 and Pulse Rate calculations. Rare conditions exists where the pulsatile waveform truly is distorted and lacks a fixed rhythm, specifically during use of an Intra-Aortic Pump (IABP).

During IABP procedures the pulsatile signal can be massively distorted without affecting the patient's SpO_2. In order to accommodate these IABP procedures without compromising the monitor's superior artifact rejection algorithm, IABP MODE is available. IABP MODE allows the user to turn off the validator algorithm so that all pulsatile data are allowed to influence the SpO_2 and Pulse Rate calculations.

NOTE

With IABP MODE turned ON, the clinician must exercise prudence in assessing the validity of the SpO_2 and Pulse Rate displays because any motion or other artifact - not just that associated with the IABP - can have a significant affect on the SpO_2 and Pulse Rate calculations.

While in IABP MODE, the displayed Pulse Rate reflects true pulsatile signal-heart rate plus the IABP ratio (e.g. #1: heart rate =120 bpm, IABP ratio = 1:1, then displayed Pulse Rate should be 120 + (120/1)=240 beats/min. e.g. #2: heart rate = 120 bpm, IABP = 1:3, then displayed Pulse Rate should be 120 + (120/3) = 180 beats/min). When in IABP MODE the Pulse Rate can be affected by motion or other artifact; the accuracy of the Pulse Rate can usually be used as an indicator of the quality of the SpO_2 display.

SPON THRESH: The SPONTANEOUS THRESHOLD SETTING adjusts the pressure threshold which the *CO_2SMO Plus!* uses to identify breaths as spontaneous or mechanical. If PIP-PEEP is greater than threshold setting, the breath is identified as mechanical; if it is less than PIP-PEEP, the breath is identified as spontaneous. The default value for the SPONTANEOUS THRESHOLD is 6 cmH_2O above the pressure baseline. This setting is found in the SETUP screen and may be set to different levels depending on the mode of ventilation. Whatever the setting, (6 cmH_2O, 10 cmH_2O or 20 cmH_2O) the *CO_2SMO Plus!* automatically sets the threshold to that level above the baseline.

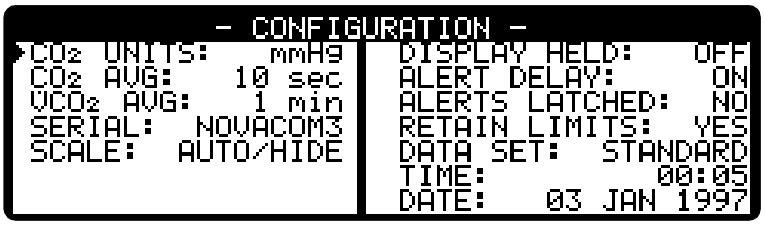
If the baseline is zero, the spontaneous threshold setting is 6 cmH_2O. Any breaths that do not cross 6 cmH_2O will be identified as spontaneous and any that do cross will be mechanical. If any PEEP is added, then the spontaneous threshold automatically adjusts to 6 cmH_2O (or whatever value is set) above the PEEP level (or baseline). So with PEEP, such as 5 cmH_2O, the spontaneous threshold is now automatically set to 11 cmH_2O. Which means that any breath that has a pressure reading below 11 cmH_2O (between 11 and 5 cmH_2O) is considered spontaneous and any that cross above 11 cmH_2O is mechanical.

With ventilators that have a PRVC (pressure regulated volume control) mode, the SPONTANEOUS THRESHOLD SETTING will have to be adjusted. This mode combines mechanical ventilation with pressure support for spontaneous breaths. This pressure support is set on the ventilator to a percentage of the total mechanical PIP. Unless the Spontaneous threshold on the *CO_2SMO Plus!* is adjusted, all breaths mechanical and spontaneous, will cross above our default SPONTANEOUS THRESHOLD SETTING and will be identified as mechanical. When using this mode of ventilation, identify the two peak pressure readings (the PIP of the mechanical breath and the PIP for the spontaneous breath during the pressure support breath) then set the SPONTANEOUS THRESHOLD SETTING approximately 3-5 cmH_2O below mechanical PIP.

As an example, if the readings were 5 cmH_2O PEEP, a mechanical PIP of 30 cmH_2O and the PIP for the spontaneous breath with pressure support at 15 cmH_2O, you would adjust the *CO_2SMO Plus!* SPONTANEOUS THRESHOLD SETTING to 20 cmH_2O (5cmH_2O PEEP + 20 cmH_2O = 25 cmH_2O). You may have to occasionally change this setting depending on patient conditions.

Configuration Settings

Additional features can be adjusted in the CONFIGURATION screen by pressing and holding the SETUP key for three seconds. Use the NEXT key to move the flashing pointer to the parameter to be set, then adjust using the △ and ▽ arrow keys. Any changes made will be retained when the monitor is turned off.



Options are listed below with descriptions following:

Parameter	**Description**	**Factory Default**
CO_2 UNITS	mmHg, %, kPa	mmHg
CO_2 AVG	1 Br., 10 sec, 20 sec Inst. (instantaneous)	10 sec
VCO_2 AVG	1 Br, 8 Br, 1 min, 3 min, 5 min, 10 min	1 min
SERIAL	Select serial interface: OFF, NOVACOM3 (used when connected to an external PC with optional software), SATDIAG (system diagnosis), VUELINK (HP VUELINK Open Interface)	OFF

SCALE	When set to AUTO/SHOW the loops and flow/pressure waveforms have reference scales and automatically adjust when changes occur. When set to AUTO/HIDE, the loops and flow/pressure waveforms do not show reference scales but will automatically adjust when changes occur. When set to MANUAL/SHOW all scale changes are made manually by pressing the NEXT key when prompted. The CO_2 scale is shown and is changed manually through the SETUP key. It will not autoscale.	AUTO/ HIDE
DATA SET	The DATA SET selection toggles between the STANDARD and PROTOCOL data screen configurations.	
DISPLAY HELD	OFF or ON (see below for explanation)	OFF
ALERT DELAY	ON or OFF. Audible alerts are delayed for ten seconds upon the detection of the violation.	ON
ALERTS LATCHED	OFF or ON (see below for explanation)	OFF
RETAIN LIMITS	YES or NO (see below for explanation)	YES
TIME	24 hour format	
DATE	Day number, short month name, year (e.g. 14-DEC-1997)	

CO_2 UNITS: Select the desired units for both the capnogram and $ETCO_2$ values.

CO_2 AVG (CO_2 Averaging): Select the interval from which the displayed value of end tidal CO_2 ($ETCO_2$) is calculated.

VCO_2 AVG (VCO_2 Averaging): Select the averaging time for the displayed value of CO_2 production (VCO_2).

DATA SET: The STANDARD set configures the data in like groups such as volumes and pressures. The PROTOCOL set configures the data screens in a ventilator management mode. Included in the PROTOCOL set are screens for ventilator SETUP, MONITORING and WEANING.

SERIAL: Select the device that will be connected to the "RS232C/NOVAMETRIX ACCESSORIES" connector on the rear panel.

DISPLAY HELD (Display Held Timer): The Display Held Timer activates if the pulse oximeter portion of the monitor cannot detect a regular and rhythmic pulsatile signal for periods longer than 10 seconds. While the Display Held Timer is active, SpO2 SEARCH: XX is displayed in the Message Center, and the SpO_2 and Pulse Rate values are not updated and the last valid values are "Held." The timer display (XX) indicates in seconds how "old" the displayed SpO_2 and pulse rate information is. Note that when the DISPLAY HELD selection is set to OFF, the values are still held but the SpO2 SEARCH time is not displayed.

The Display Held Timer can be activated by:

- excessive motion
- improper sensor placement
- interference from electrosurgical devices
- ambient light interference
- low (pulsatile) signal strength

ALERT DELAY: When set to “ON” the monitor will delay the audible alert for 10 seconds upon the detection of an alert violation.

ALERTS LATCHED: The monitor will indicate an alert condition once detected. If this option is set to “ON” the visual alert indication will continue even if the condition no longer exists. The monitor will continue to indicate an alert until acknowledged by pressing the key.

RETAIN LIMITS: When set to “YES” all alert limits and setup and configuration settings will be retained when power is cycled. If set to “NO” then the factory default alert limits and settings will be loaded the next time the monitor is turned on.

TIME and DATE: Select to program or change the time and date. The format is “TIME: HH:MM DDmmmYYYY” where HH=hours from 00-23, MM=minutes from 00-59, DD=days of the month from 01-31, mmm=month, YYYY=year (using all four digits).

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Section 4 *Sensors and Patient Connections*

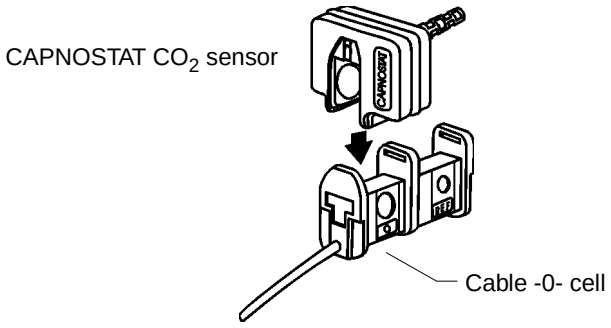
The *CO_2SMO Plus!* calculates various flow, CO_2 and pulse oximetry related parameters. Flow, CO_2 and pulse oximetry sensors can be used simultaneously or in any combination.

Initializing the CAPNOSTAT CO_2 Sensor

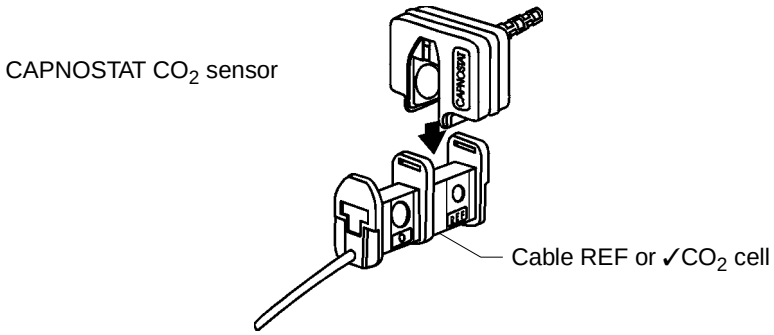
When a new CAPNOSTAT CO_2 sensor is attached to the monitor, or is moved from one monitor to another, the monitor will prompt "PUT SENSOR ON -0- CELL". This will enable the monitor to initialize the CAPNOSTAT CO_2 sensor. The CAPNOSTAT CO_2 sensor will not need to be initialized again as long as it is used with the same monitor.

When "PUT ON -0- CELL" appears in the CO_2 section of the display:

1. Place the CAPNOSTAT CO_2 sensor on the cable -0- cell. The monitor will respond "ZEROING ON -0- CELL: XX" (XX = seconds remaining).



2. After approximately 10 seconds the message "PUT CO2 SENSOR ON REFERENCE CELL" is displayed. Place the CAPNOSTAT CO_2 sensor on the cable -REF- cell (may be labelled ✓CO_2). The monitor should display "CHECKING ON CELL".



3. The monitor sounds a short "beep" and will display "SENSOR PASSED." After a few seconds, the message "PUT CO2 SENSOR ON ADAPTER IN ROOM AIR, OK: △ CANCEL: ▽" will display. The CAPNOSTAT CO_2 sensor has been initialized **BUT IS NOT READY FOR PATIENT USE**.

4. Place the CAPNOSTAT CO_2 sensor on a new (or clean reusable) airway adapter of the type that is to be used. Room air must be in the airway adapter, and it must be out of the ventilator circuit.
DO NOT USE THE CABLE -0- CELL FOR THIS PROCEDURE!

5. Press △ to begin adapter zero.

NOTE

If the monitor detects breaths at this time, the message "BREATHS DETECTED" will be displayed, and the adapter zero will not be allowed until 20 seconds has passed with no detected breaths.

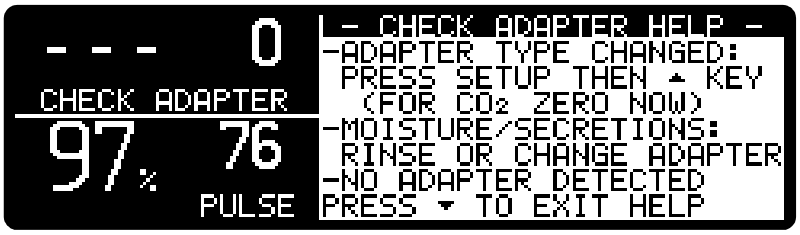
6. The monitor will respond "ZEROING CO2 ON AIRWAY ADAPT: XX" (XX - seconds remaining). Refer to the following section for other CAPNOSTAT CO_2 sensor zero requirements.

   Whenever a CAPNOSTAT CO_2 sensor is initialized an adapter zero must follow. Once an adapter zero has been performed it does not have to be performed again unless/until a different type of airway adapter or the sidestream adapter is used.

Adapter Zero

An adapter zero allows the monitor to accommodate the optical characteristics of each different type of adapter. The monitor will prompt for an adapter zero whenever the type of adapter (single patient use, reusable, adult/pediatric or neonatal) being used to monitor the patient is changed. An adapter zero should also be done each time the tubing set is changed when using the sidestream adapter.

When the monitor prompts "CHECK ADAPTER HELP: PRESS △" and the △ key is pressed the following screen will appear.



To perform an adapter zero:

1. Place the CAPNOSTAT CO_2 sensor on the adapter (or cannula tubing for sidestream adapter) and allow the CAPNOSTAT CO_2 sensor to reach operating temperature.
DO NOT USE THE CABLE -0- CELL FOR THIS PROCEDURE!

2. Press SETUP then select ZERO NOW using the NEXT key, then press △. The monitor will display "PUT CO2 SENSOR ON ADAPTER IN ROOM AIR OK: △ CANCEL: ▽" (or "ATTACH CANNULA ON ADAPTER IN ROOM AIR OK: △ CANCEL: ▽" if the sampling pump is on). Room air must be in the airway adapter, and it must be out of the ventilator circuit. Press △ to start the adapter zero.

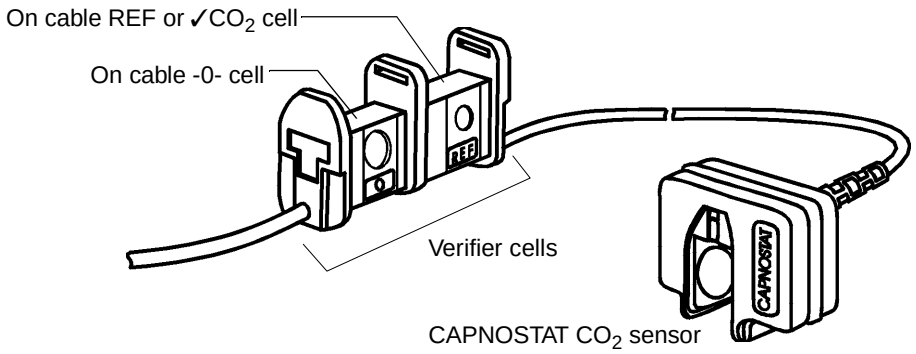
NOTE

If the monitor detects breaths at this time, the message “BREATHS DETECTED” will be displayed, and the adapter zero will not be allowed until 20 seconds has passed with no detected breaths.

3. The monitor will respond “ZEROING CO2 ON AIRWAY ADAPT: XX” or “ZEROING CO2 ON CANNULA:XX” if the sampling pump is on (XX = seconds remaining).

On-Cable Verifier Cells

The on-cable verifier cells consist of a zero (-0-) and a reference (REF or ✓CO_2) cell. They are used for CAPNOSTAT CO_2 sensor initialization, for sensor zeroing when prompted by the monitor (only if changes in the sensor are detected), verifying the accuracy of the sensor, or for parking the sensor when not monitoring.



The CAPNOSTAT CO_2 sensor can be placed on the reference cell (labelled as ✓CO_2 on some verifier cells) whenever the user wishes to verify the sensor’s accuracy. Once placed on the reference cell, the monitor will display “CHECKING ON CELL.” The $ETCO_2$ value should read between 36 and 40 mmHg. The monitor will sound a short “beep,” display “SENSOR PASSED” for 15 seconds, then enter a standby state (CO_2 section of the display only).

The zero cell can also be used to park the CAPNOSTAT CO_2 sensor. When the sensor is placed on the zero cell prior to placing the unit into operation, or before CO_2 is detected, the message “SENSOR ON CELL CO2 ZERO NOT REQUIRED AT THIS TIME” will be displayed for 15 seconds. After 15 seconds have passed, the CO_2 section of the display will enter a standby state.

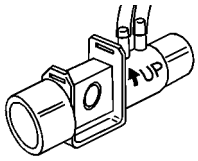
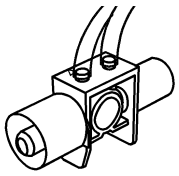
The only time that the monitor will perform a zero on the zero cell is for initialization of a sensor or if the monitor detects a change in the sensor, in which case it will display “PUT ON -0- CELL”. Should this occur, follow the screen instructions to zero the sensor.

The monitor will request a reference check following an on-cable (cell) zero. If the reference $ETCO_2$ value is not between 36 and 40 mmHg, another cell zero will be requested. If the situation is not corrected within three repetitions of this sequence, the monitor will request service.

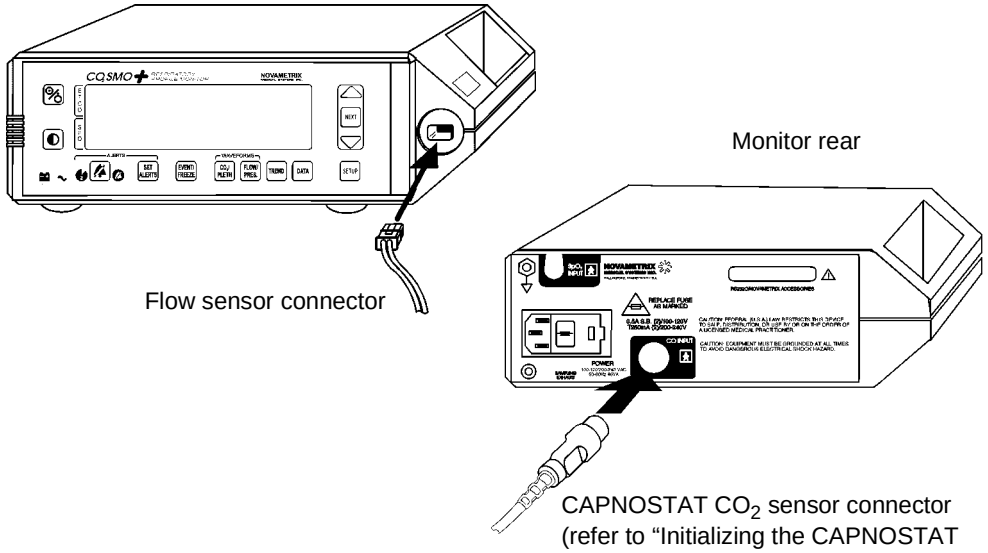
Combined CO_2 and Flow

To monitor flow (respiratory mechanics) and CO_2, a combined CO_2 airway adapter and flow sensor (CO_2/flow sensor) is available.

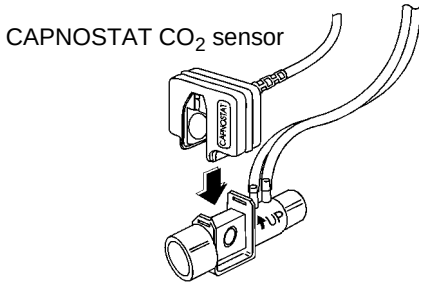
1. Select a *Series 3* CO_2/flow sensor based on the patient:

	**Pediatric/Adult Combined CO_2/Flow Sensor (Catalog No. 6719):** • For intubated patients with endotracheal tube diameters greater than 4mm. Adds approximately 6.5 cc of deadspace.
	**Neonatal Combined CO_2/Flow Sensor (Catalog No. 6720):** • For intubated patients with endotracheal tube diameters equal to or less than 4mm. Adds less than 1 cc of deadspace.

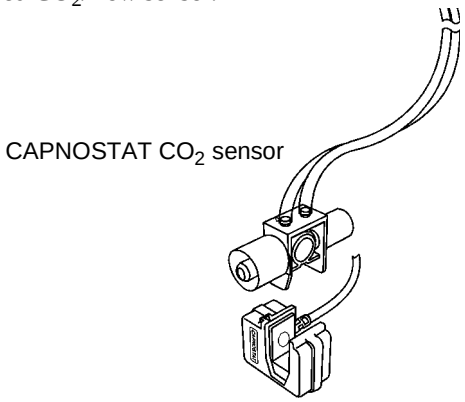
2. Connect flow and CO_2 sensors to the *CO_2SMO Plus!*. Use only *Series 3* CO_2/flow sensors.


Monitor rear
Flow sensor connector
CAPNOSTAT CO_2 sensor connector
(refer to "Initializing the CAPNOSTAT
CO2 Sensor" at the beginning of this section)

3. Connect the CAPNOSTAT CO_2 sensor to the combined CO_2/flow sensor.

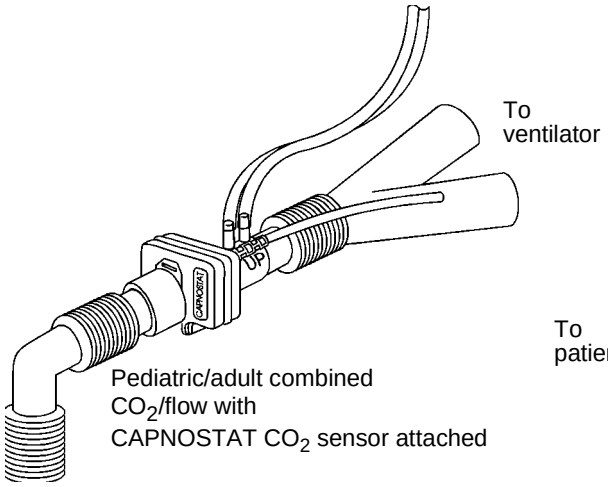


Pediatric/adult
Combined CO_2/Flow sensor
(added deadspace: 6.5cc)

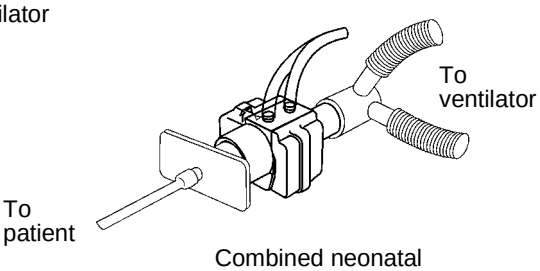


Neonatal
Combined CO_2/flow sensor
(added deadspace: < 1 cc)

4. Connect the combined CO_2/flow sensor to the patient breathing circuit.



Pediatric/adult combined
CO_2/flow with
CAPNOSTAT CO_2 sensor attached



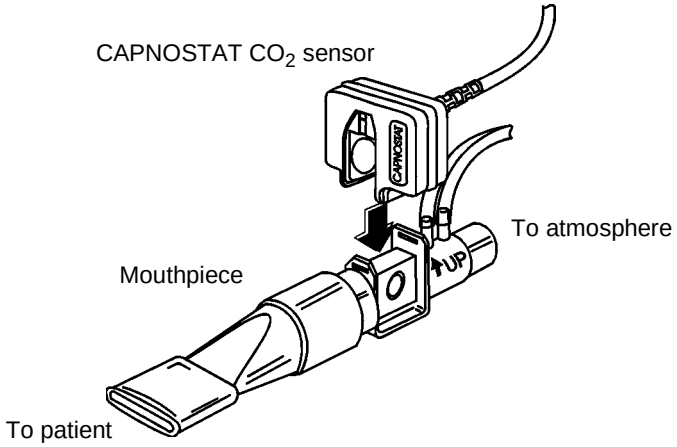
Combined neonatal
CO_2/flow sensor with
CAPNOSTAT CO_2 sensor
attached

NOTE

- Do NOT place the airway adapter between the ET tube and the elbow (pediatric/adult circuit), as this may allow patient secretions to block the adapter windows.
- Position the airway adapter with its windows in a vertical and NOT a horizontal position: this helps keep patient secretions from "pooling" on the windows.
- To prevent "rain-out" and moisture from draining into the airway adapter, do NOT place the airway adapter in a gravity dependent position.
- Periodically check the flow sensor and tubing for excessive moisture or secretion build up.

- For routine performance of airway care, separate the system between the ET tube and the airway adapter (neonatal circuit), or between the ET tube and elbow (pediatric/adult circuit). Lavage and suctioning of the airway can then be performed without fluids and mucous accumulating on the airway adapter windows.

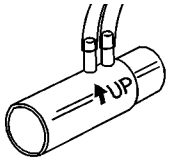
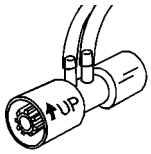
NOTE: For non-intubated patients the combined CO_2 adapter/flow sensor with mouthpiece can be used.



Monitoring Flow (Respiratory Mechanics) Separately

To monitor flow (respiratory mechanics) without CO_2:

1. Select a *Series 3* flow sensor based on the patient:

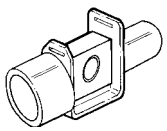
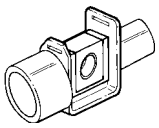
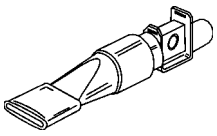
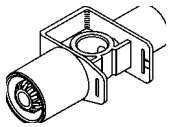
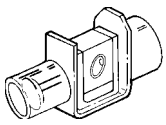
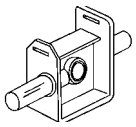
	**Pediatric/Adult Flow Sensor (Catalog No. 6717):** • For intubated patients with endotracheal tube diameters greater than 4mm. Adds approximately 6.5 cc of deadspace.
	**Neonatal Flow Sensor (Catalog No. 6718):** • For intubated patients with endotracheal tube diameters equal to or less than 4mm. Adds less than 1 cc of deadspace.

2. Attach the Flow sensor to the monitor and patient circuit as described in "Combined CO_2 and Flow" on page 26.

Monitoring CO_2 Separately

To monitor CO_2 without flow (respiratory mechanics):

1. Select an airway adapter based on the patient and monitoring situation.

	**Pediatric/Adult Single Patient Use Adult Airway Adapter (Catalog No. 6063):** • For intubated patients with endotracheal tube diameters greater than 4 mm. Adds approximately 5 cc of deadspace; • For connecting to anesthesia, non-rebreathing, or BIPAP/CPAP masks for non-intubated patients.
	**Pediatric/Adult Adult Reusable Airway Adapter (Catalog No. 7007):** • For intubated patients with endotracheal tube diameters greater than 4 mm. Adds approximately 5 cc of deadspace; • For connecting to anesthesia, non-rebreathing, or BIPAP/CPAP masks for non-intubated patients.
	**Pediatric/Adult Single Patient Use Airway Adapter with mouthpiece (Catalog No. 6421):** • For point-of-care monitoring of pediatric or adult patients. Adds approximately 8 cc of deadspace.
	**Neonatal/Pediatric Single Patient Use Airway Adapter (Catalog No. 6312):** • For intubated patients with endotracheal tube diameters no more than 4 mm. Adds approximately .5 cc of deadspace.
	**Neonatal/Pediatric Reusable Airway Adapter (Catalog No. 7053):** • For intubated patients with endotracheal tube diameters no more than 4 mm. Adds approximately .5 cc of deadspace.
	**Sampling Adapter (Catalog No. 5843):** • For monitoring non-intubated patients with nasal cannulas. • For monitoring pediatric tracheostomy patients.

2. Attach the CAPNOSTAT CO_2 sensor to the monitor and adapter as described for the Combined CO_2/flow sensor, or see the following section if using the sampling adapter.

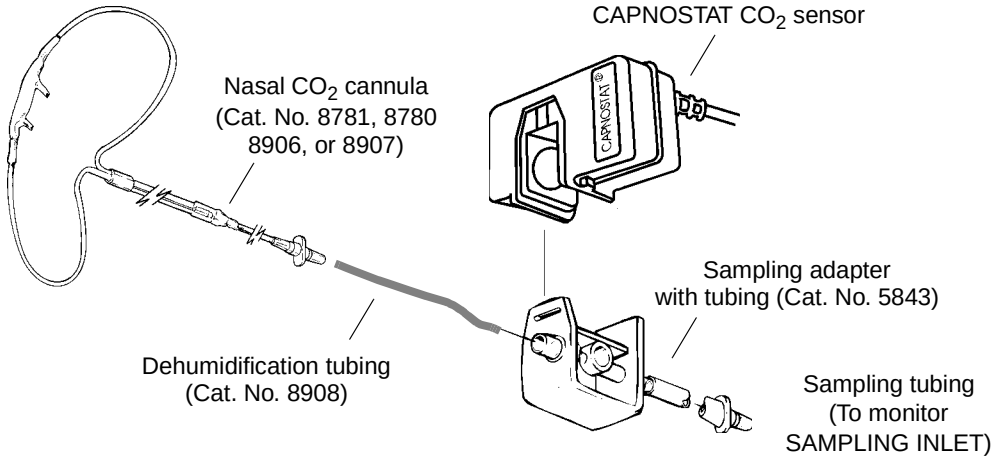
Sampling Adapter

The sampling airway adapter with tubing (Catalog No. 5843) should be used in conjunction with a nasal sampling cannula to monitor non-intubated patients.

1. Verify that the windows are clean and dry. Clean or replace the adapter if necessary.
2. Align the arrow on the bottom of the sampling adapter with the arrow on the bottom of the CAPNOSTAT CO_2 sensor and press the sensor and adapter together until they "click."
3. Connect the sampling tubing to the SAMPLING SYSTEM INLET port located on the front of the monitor.
4. Connect a dehumidification tubing set to the sampling adapter.

   (Use of the Nafion* Dehumidification Tubing Set (Cat. No. 8908) is optional but highly recommended—especially during high humidity or lengthy monitoring episodes.)
5. Connect a Nasal CO_2 sampling cannula to the dehumidification tubing set (or to the sampling adapter if not using the dehumidification tubing).

Cat. No.	Cannula Type
8781	Nasal CO_2 Sampling Cannula—Adult
8780	Nasal CO_2 Sampling Cannula—Pediatric
8906	Nasal CO_2 Sampling and O_2 Delivery Cannula—Adult
8907	Nasal CO_2 Sampling and O_2 Delivery Cannula—Pediatric



6. Ensure that the sampling pump is turned on—the pump icon ( ) will be displayed.

   To turn the sampling pump on (or off):
   - Press the SETUP key;
   - Use the NEXT key until the arrow points to the PUMP selection;
   - Use the ▲▼ keys to turn the pump ON (or OFF).

*Nafion is a registered trademark of Dow Corning Corp.

7. Adapter zero is necessary when the pump is first turned on to set the sampling system alert thresholds and adjust to the optical characteristics of the sampling adapter. After the first sampling adapter zero, subsequent patient setups using the sampling adapter do not require an adapter zero unless:
   - Different tubing lengths or configurations have been used since the last use with a sampling adapter.
   - The system was zeroed to a different adapter (for example, an adult airway adapter) since the last use with a sampling adapter.
   - The monitor displays "ATTACH CANNULA ON ADAPTER IN ROOM AIR OK: △ CANCEL: ▽".

   To perform a Sampling Adapter zero:
   - Press the SETUP key (the pointer should be next to the CO_2 ZERO NOW selection; if not, use the NEXT key to select CO_2 ZERO NOW in the CO2 SETUP section).
   - Press the △ key. Verify that the cannula (and dryer tubing, if used) is attached to the adapter and sampling room air, and that the adapter tubing is attached to the monitor.

NOTE

Place the cannula away from all sources of CO_2 including patient and operator breath, and ventilator exhaust valves.

   - Press the △ key to initiate the zero (a countdown timer will count from 10 seconds).

NOTE

If the monitor detects changing CO_2 levels (breaths) during an adapter zero, BREATH DETECTED? is displayed followed by ATTACH CANNULA AND SAMPLE ROOM AIR. To continue, remove the source of CO_2, wait 30 seconds, and press the △ key.

8. If using a Nasal CO_2 Sampling and O_2 Delivery Cannula, attach the O_2 tubing to the administration device and set the device to the prescribed O_2 setting.

9. Position the cannula on the patient.

   Insert the cannula tips into the nostrils, pass the cannula tubing over the ears, then slide the retaining sleeve up the tubing toward the neck to a comfortable fit under the chin.

10. Check that the connections have been made properly by examining the CO_2 waveform (capnogram) on the monitor display.

11. Using the CAPNOSTAT CO_2 sensor holding clip, secure the sensor in a convenient place (such as the on the patient's clothing or bedding).

NOTE

If possible, position the Sampling Adapter with its windows in a vertical, and NOT a horizontal position; this helps keep moisture from "pooling" on the windows.

To prevent "rain-out" and moisture from draining into the Sampling Adapter, do NOT place the Sampling Adapter in a gravity dependent position.

12. The twist clips may be used to connect the sensor cable and sampling tubing together.

NOTE

CO_2, respiratory rate and the capnogram are the only data available when using the CAPNOSTAT CO_2 sensor with the sampling airway adapter.

Flow Calibration/Zeroing

Flow sensor calibration is not necessary due to the consistency from one flow sensor to the next. Also, the flow signal is automatically zeroed periodically by internal valves. The flow zero will freeze any displayed waveform for one second, and display a "FLOW ZERO IN PROGRESS" message during the zero. If additional flow sensor zeros are desired, press SETUP and then press NEXT until the pointer is next to the FLOW ZERO NOW selection in the RESP MECH setup section, then press the ⌓ key.

NOTE

When the battery is low (blinking on front panel) the monitor will not zero the flow sensor. This may cause the calculations based on the flow signal to drift outside of normal performance specifications. Connect to AC power as soon as possible.

SpO_2 Sensors

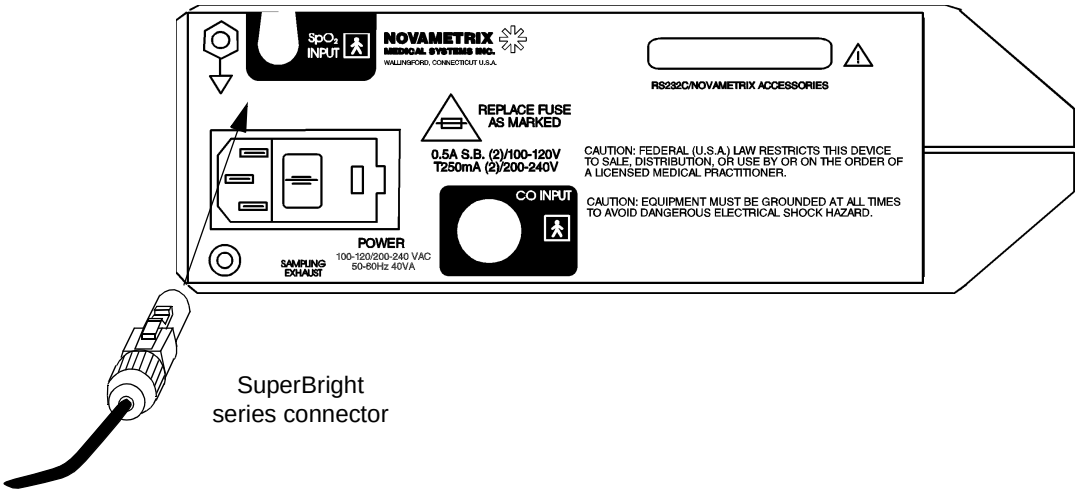
This section explains how to select an SpO_2 sensor, how to connect the sensor to the monitor, and how to apply the sensor to the patient.

CAUTION

Connect only Novametrix SpO_2 sensor extension cables and/or SuperBright™ SpO_2 sensors to the *CO_2SMO Plus!*. Do not use other SpO_2 sensors or accessories with *CO_2SMO Plus!*. Before connecting to the patient or to the monitor, ensure that sensor extension cables and/or sensors are physically intact, with no broken, frayed or damaged components.

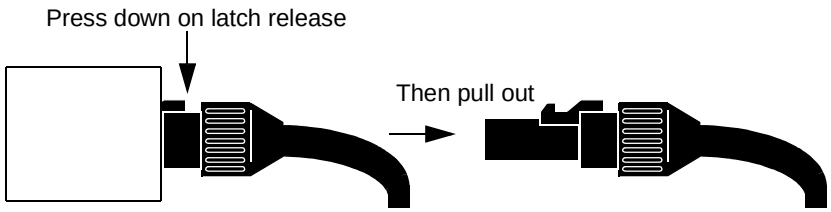
To attach a SuperBright sensor or sensor extension cable to *CO_2SMO Plus!*:

1. Plug the connector into the rear panel SpO_2 sensor input.


SpO2 INPUT
NOVAMETRIX
MEDICAL SYSTEMS INC.
WALLINGFORD, CONNECTICUT U.S.A.
RS232C/NOVAMETRIX ACCESSORIES
REPLACE FUSE AS MARKED
0.5A S.B. (2)/100-120V
T250mA (2)/200-240V
CAUTION: FEDERAL (U.S.A.) LAW RESTRICTS THIS DEVICE TO SALE, DISTRIBUTION, OR USE BY OR ON THE ORDER OF A LICENSED MEDICAL PRACTITIONER.
CO INPUT
CAUTION: EQUIPMENT MUST BE GROUNDED AT ALL TIMES TO AVOID DANGEROUS ELECTRICAL SHOCK HAZARD.
POWER
100-120/200-240 VAC
50-60Hz 40VA
SAMPLING EXHAUST
SuperBright
series connector

The connector clicks into place when properly seated. *Do not twist the connector.* Sensors may be connected or removed whether or not the monitor is turned on.

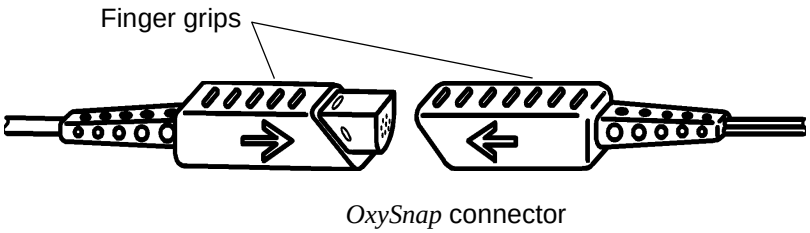
2. To disconnect, press the latch release lever, then pull the connector from the monitor. Do not twist the connector.



OxySnap™ Connectors

To connect an *OxySnap* extension cable to an *OxySnap* SuperBright sensor:

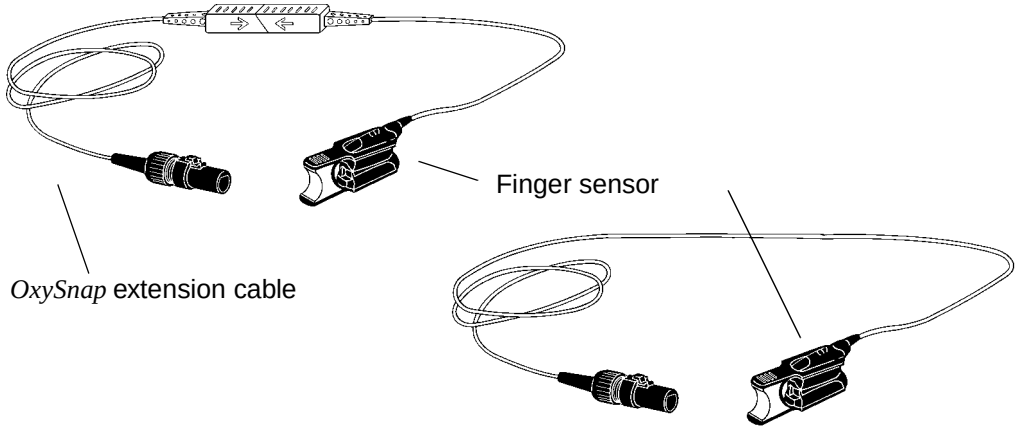
1. Align the arrows on the *OxySnap* connectors and press the connectors together.



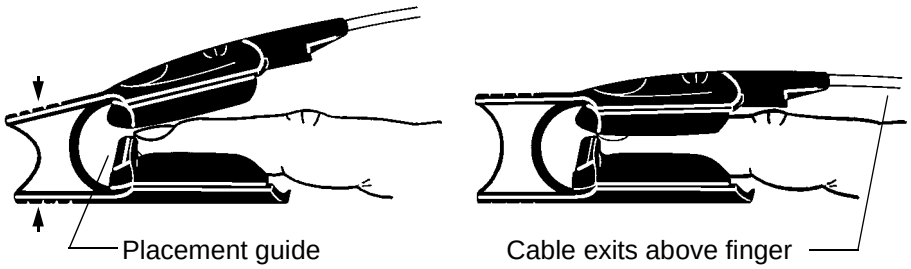
2. To disconnect, grasp the connectors at the finger grips and pull them apart.

Finger Sensor

The reusable Finger Sensor is intended for adult or appropriate size pediatric fingers and is not designed for neonatal applications.



1. Gently squeeze the grips at the rear of the sensor (indicated by arrows below).



2. Position fingertip against placement guide with fingernail toward the red light.

   Do not position the finger so as to protrude past the placement guide.

3. Release the finger grips.

WARNING

Inspect the site often for adequate circulation—at least once every four hours. When applying sensors take note of patient's physiological condition. For example, burn patients may exhibit more sensitivity to heat and pressure and therefore additional consideration such as more frequent site checks may be appropriate.

4. To remove sensor, gently squeeze grips and slide the sensor from the finger.

CAUTION

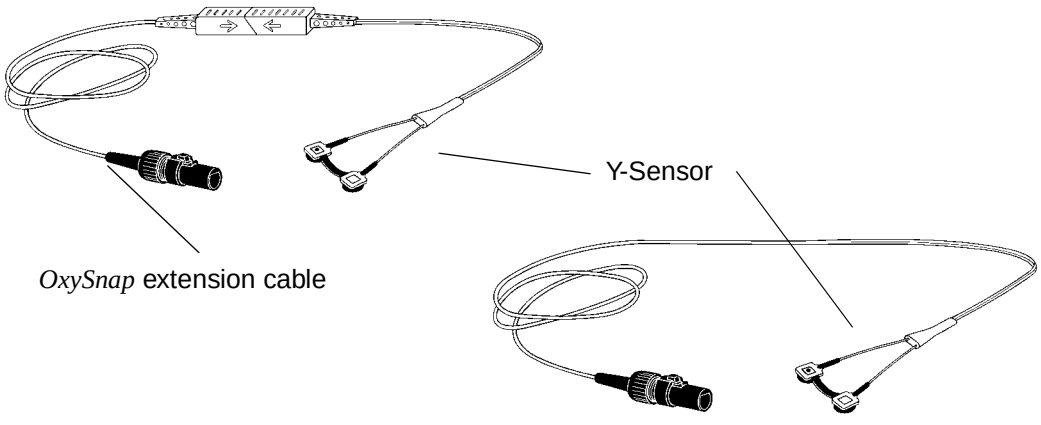
Overstretching the pulse oximeter finger sensor can damage the sensor and potentially affect pulse oximeter readings. Do not stretch the finger sensor open beyond the limit for which it was designed. Overstretching can be prevented: avoid opening the sensor by any means other than squeezing the grips; *DO NOT* force the sensor onto large objects such as a bedrail.

Finger Sensor Quick Check

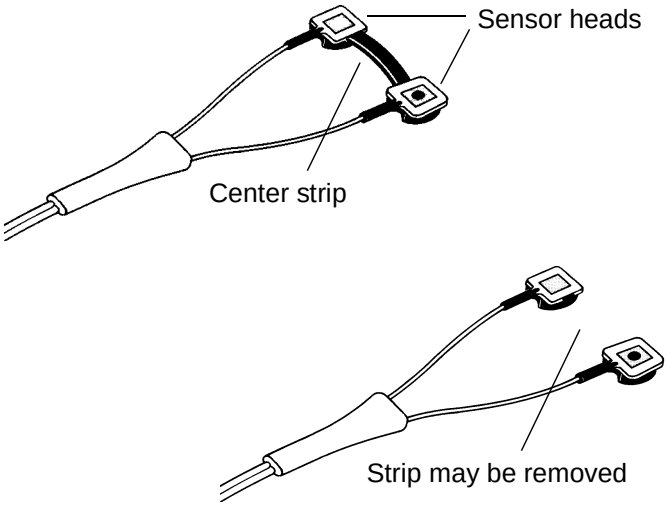
1. Is "PROBE OFF" displayed when the sensor is connected to the monitor but not applied to the patient?
2. Apply the sensor to your index finger. Are reasonable SpO_2 and pulse rate values displayed?
3. A YES to BOTH #1 and #2 indicates that the sensor is OK. Apply the sensor to the patient as instructed above. The quick check is also a functional test of the extension cable.

Y-Sensor™

The reusable Y-Sensor is a flexible sensor designed for use on any patient. It is secured to the patient using a Y-Strip tape, foam wrap, or ear clip (see below).

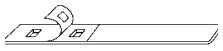


The Y-Sensor center strip is not a functional part of the sensor. Its twofold purpose is to aid in the placement of the sensor into the Y-Strip or other securing system and to keep the distance between the sensor heads to no more than 25 mm. The center strip may be removed (carefully cut away) if the distance between the sensor heads needs to be reduced to less than 25 mm.



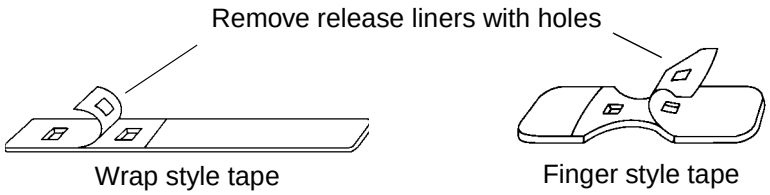
Y-Sensor Application using Y-Strip Tapes or Foam Wrap

Select a Y-Strip or foam wrap based on the patient type and intended sensor location.

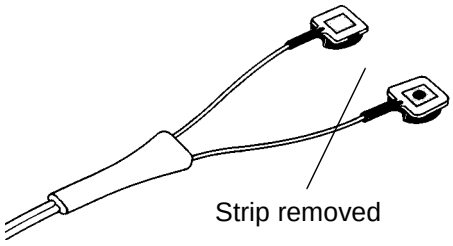
	**Wrap Style Tapes:** Y-Strip tapes are available in two color coded sizes: 25 mm tapes have green liners, and 20 mm tapes have blue liners. The size refers to the distance between the holes in the tape. • Catalog No. 8828: 20mm (blue) neonatal foot, hand, pediatric toe, finger • Catalog No. 8829: 25mm (green) neonatal foot, hand
	Finger Style Tapes: • Catalog No. 8831: 20mm (blue) pediatric finger, adult finger • Catalog No. 8832: 25mm (green) adult finger
	Non-Adhesive Foam Wraps: • Catalog No. 8836, Large: adult/pediatric finger, neonatal/pediatric foot or hand • Catalog No. 8943, Small: neonatal foot or hand, pediatric toe or finger

To use the Y-Strip tapes:

1. Remove the portion of the release liner containing the holes.



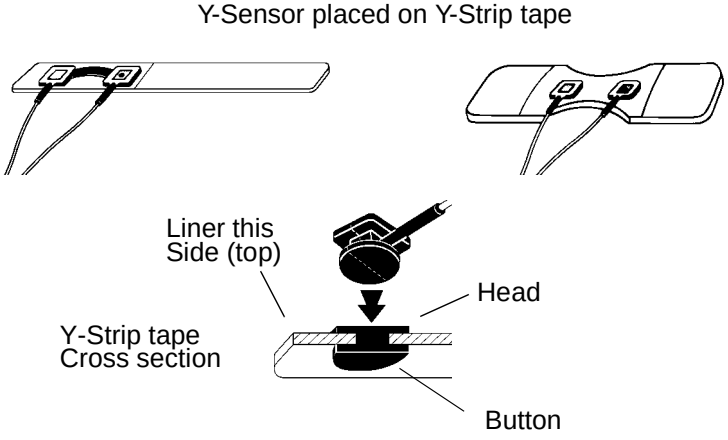
2. *(Omit this step if using the 25 mm Y-Strip tape.)*
   If using the 20 mm Y-Strip tape, carefully remove the Y-Sensor center strip using a pair of scissors or a sharp blade.



   The center strip does not effect sensor operation; its purpose is to aid putting the sensor into the 25 mm tape and to keep the distance between the sensor heads at 25 mm.

3. Press the "button" on the back of each sensor head through a hole in the tape.

   Press in from the sticky side of the tape. The tape will stretch to fit the sensor button.



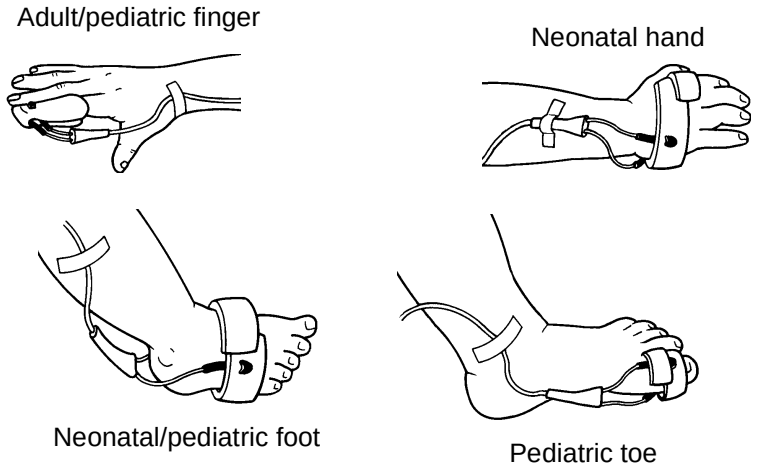
4. Remove the remaining release liner(s) if applicable and apply the sensor/tape to the patient.

   Make certain that the sensor heads are directly opposite each other through the tissue. This prevents the sensor from being placed on a site too thick for proper operation.

   Position the sensor so that the tape does not extend over the space between the fingers or toes to insure that there will be no light transmission through this space.

5. To maximize sensor life, secure the cable along the limb with tape as shown in the following illustrations.

Leave slack in the wires between the tape and the sensor.

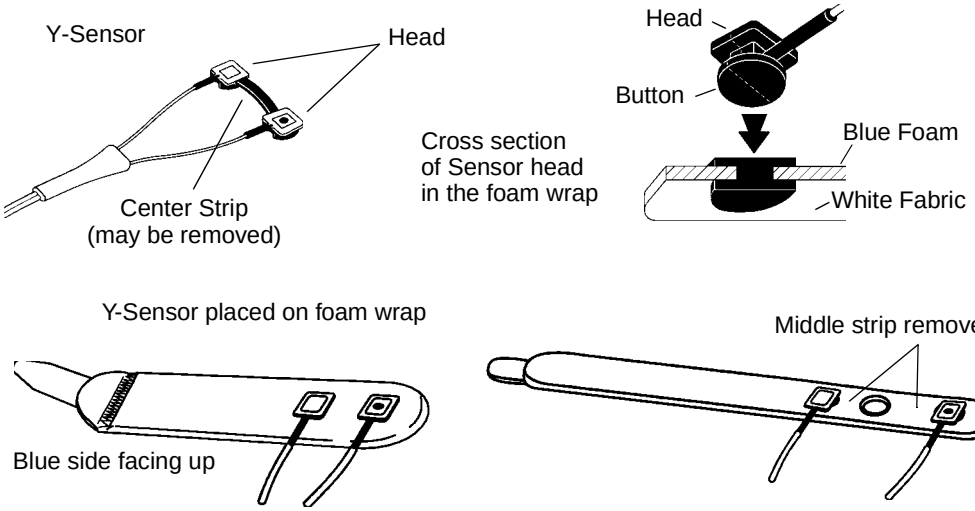


WARNING

Do not wrap the tape around the limb so tightly that circulation is restricted.
Inspect the site often for adequate circulation—at least once every four hours. When applying sensors take note of patient's physiological condition. For example, burn patients may exhibit more sensitivity to heat and pressure and therefore additional consideration such as more frequent site checks may be appropriate.

To use the non-adhesive foam wrap:

1. With the blue side of the foam wrap facing up, press the buttons on the back of each Y-sensor head through the holes in the foam wrap. The wrap will stretch to fit the buttons.



NOTE

If using the first and third holes on the foam wrap it may be necessary to cut the middle strip off the Y-sensor.

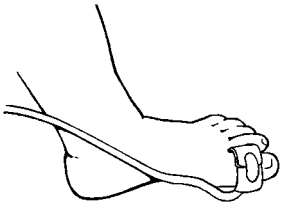
2. Face the blue side of the wrap toward the skin and wrap around the site (cut excess foam if necessary on small version). Secure with the Velcro® tab.

WARNING

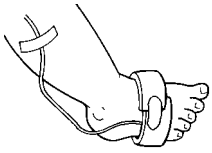
Do not wrap the tape around the limb so tightly that circulation is restricted.
Inspect the site often for adequate circulation—at least once every four hours. When applying sensors take note of patient's physiological condition. For example, burn patients may exhibit more sensitivity to heat and pressure and therefore additional consideration such as more frequent site checks may be appropriate.

3. *Ensure the sensor heads are directly opposite each other through the tissue.* This prevents the sensor from being placed on a site too thick for proper operation.

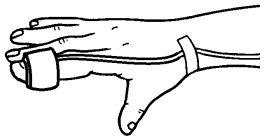
Neonatal hand



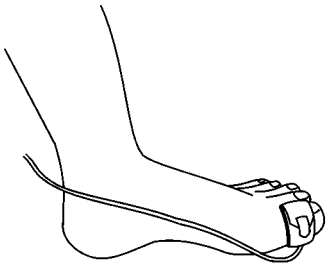
Pediatric toe



Neonatal/pediatric foot



Adult/pediatric finger



Adult toe

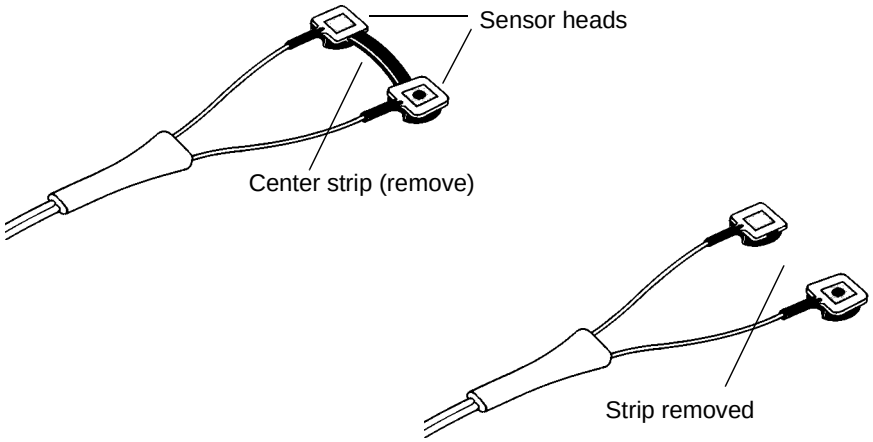
4. Position the sensor so that the foam wrap does not extend over the spaces between the fingers or toes. This ensures no light transmission through this space. To maximize sensor life, secure the cable along the limb with tape as shown in the following illustrations.

WARNING

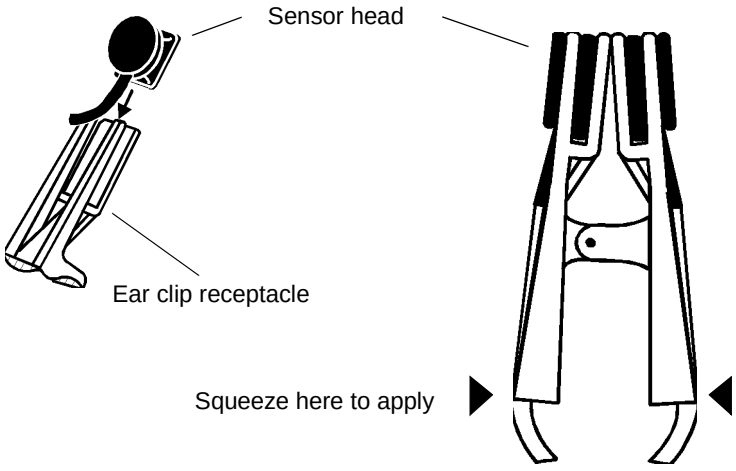
Treat foam wrap in accordance with hospital protocol for single-patient use. Check site regularly to ensure adequate circulation and proper sensor positioning.

Y-Sensor Application using Ear Clip

1. Remove center strip from the Y-Sensor.

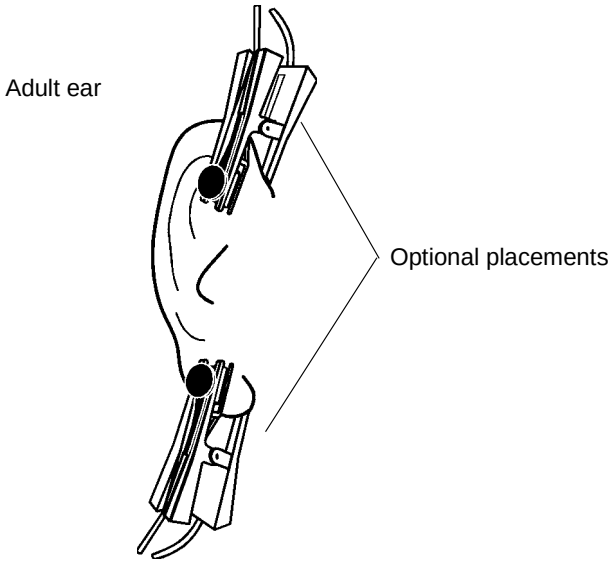


2. Slide each Y-Sensor head into the ear clip‘s receptacles. The heads should face each other.



3. Gently squeeze the end of the ear clip (shown in diagram), and apply the sensor to the patient.

If a satisfactory reading cannot be obtained, rub the site and/or use adhesive dots for better response. The adhesive dots (Catalog No. 8700) included with the ear clips will also help in preventing the ear clip from falling off (during exercise for example).



WARNING

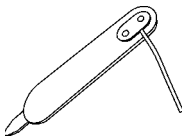
Inspect the site often for adequate circulation—at least once every four hours. When applying sensors take note of patient's physiological condition. For example, burn patients may exhibit more sensitivity to heat and pressure and therefore additional consideration such as more frequent site checks may be appropriate.

Y-Sensor Quick Check

1. With the Y-Sensor connected to the monitor but not applied to patient, position the sensor heads so that they face each other (the red light shines at the detector). Is "PROBE OFF" displayed?
2. Tape the Y-Sensor to your index finger. Does the monitor show reasonable SpO_2 and pulse rate values?
3. A YES to BOTH #1 and #2 indicates that the sensor is working properly. Apply the sensor to the patient as instructed above. The quick check is also a functional test of the extension cable.

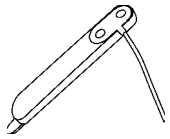
Single Patient Use SpO_2 Sensors

Select a Y-Strip or foam wrap based on the patient type and intended sensor location.



Single Patient Use Pediatric/Adult Sensor (Catalog No. 6455):

- The single patient use SpO_2 sensor can be used when monitoring adult or pediatric patients with Novametrix Pulse Oximeters (SuperBright series).



Single Patient Use Neonatal/Pediatric Sensor (Catalog No. 6480):

- The single patient use SpO_2 sensor can be used when monitoring neonatal or pediatric patients with Novametrix Pulse Oximeters (SuperBright series).

WARNING

Use the Single Patient Use sensor and DB9 extension cable only with Novametrix SuperBright compatible pulse oximeters. Use with any other device may result in equipment damage or patient injury.

CAUTION

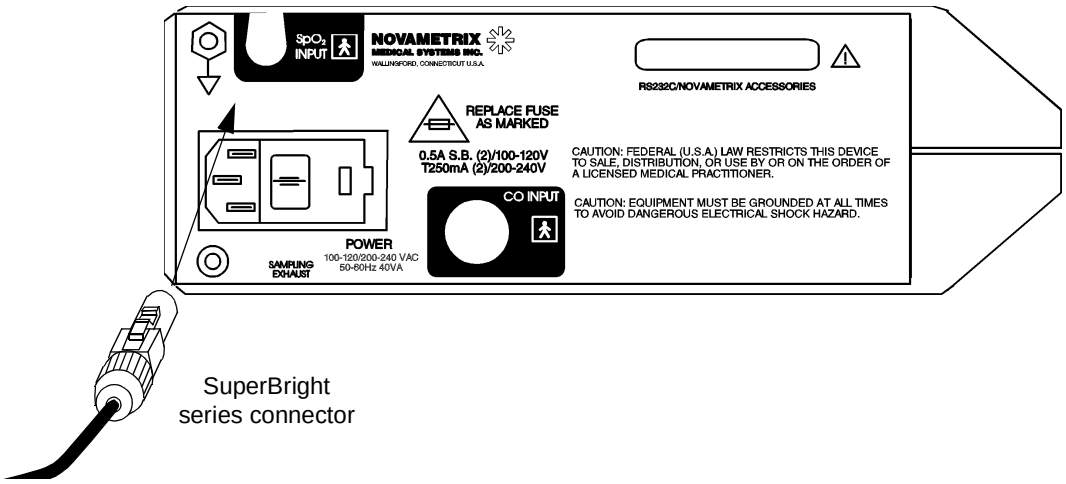
These SpO_2 sensors are intended for single patient use. The sensors can be reapplied to various sites on the same patient but should not be used on multiple patients. Do not attempt to clean or disinfect the sensor, as system performance will be compromised.

NOTE

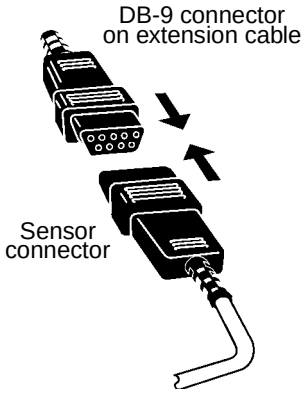
The Single Patient Use sensor should be discarded if sensor integrity becomes questionable.

Single Patient Use SpO_2 Sensor Application

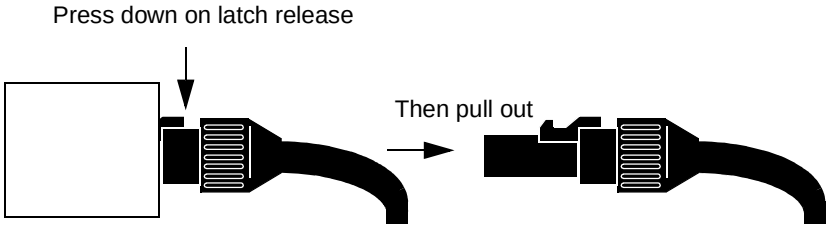
1. Connect the DB-9 extension cable to the *CO_2SMO Plus!* rear panel connector.


SpO2 INPUT
NOVAMETRIX
MEDICAL SYSTEMS INC.
WALLINGFORD, CONNECTICUT U.S.A.
RS232C/NOVAMETRIX ACCESSORIES
REPLACE FUSE AS MARKED
0.5A S.B. (2)/100-120V
T250mA (2)/200-240V
CAUTION: FEDERAL (U.S.A.) LAW RESTRICTS THIS DEVICE TO SALE, DISTRIBUTION, OR USE BY OR ON THE ORDER OF A LICENSED MEDICAL PRACTITIONER.
CO INPUT
CAUTION: EQUIPMENT MUST BE GROUNDED AT ALL TIMES TO AVOID DANGEROUS ELECTRICAL SHOCK HAZARD.
POWER
100-120/200-240 VAC
50-60Hz 40VA
SAMPLING EXHAUST
SuperBright series connector

2. Press the connector on the end of the extension cable into the connector on the end of the Single Patient Use sensor.

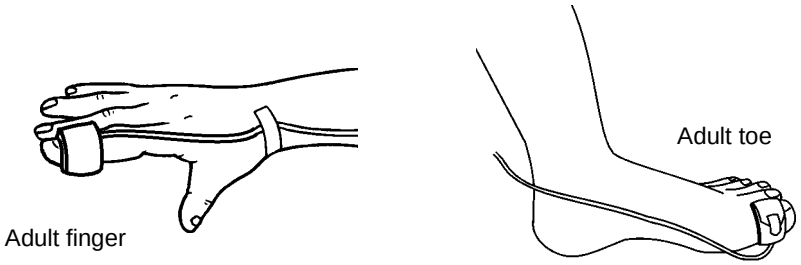


3. To disconnect the DB-9 extension cable from the sensor, grasp the connectors and pull them apart. To disconnect the DB-9 connector from the *CO_2SMO Plus!*, press the latch release lever on the extension cable connector and pull the connector straight back away from the monitor. DO NOT twist the connector.

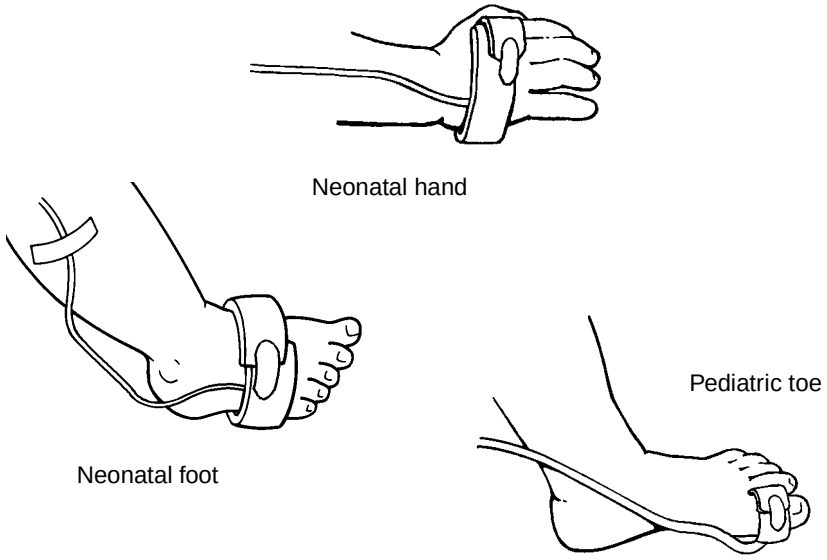


4. Select the appropriate size sensor based on the patient type.

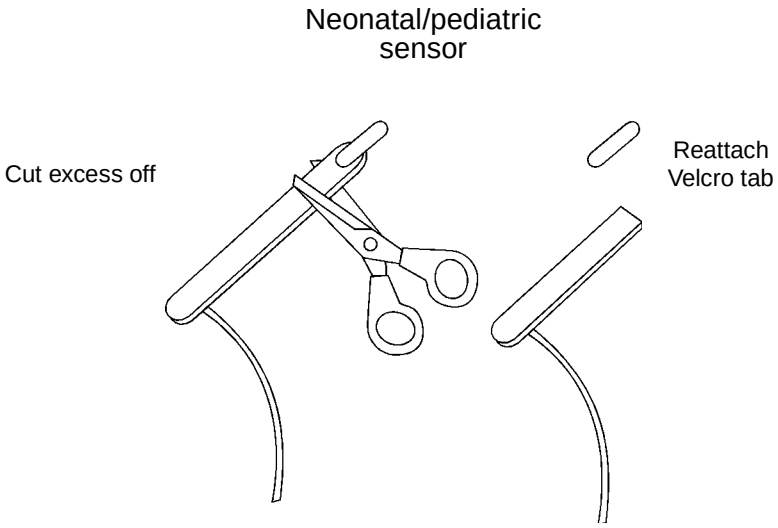
Pediatric/adult sensor



Neonatal/pediatric sensor



5. To apply the sensor, place the blue side of the sensor wrap against the skin, wrap it around the site and secure with Velcro† tab. The Velcro tab on the neonatal/pediatric version is removable to allow the foam wrap to be cut before applying to the patient.



Make certain that the sensor heads are positioned directly opposite each other through the tissue. The adhesive dots (Catalog No. 8700) which are included with each sensor can be applied to the sensor before patient application for additional adhesion to the site.

6. For additional support, secure the cable along the limb with tape.

WARNING

Do not wrap the sensor around the limb so tightly that circulation is restricted. Inspect the site often, at least every four hours, for adequate circulation. When applying sensors take note of patient's physiological condition. For example, burn patients may exhibit more sensitivity to heat and pressure and therefore additional consideration such as more frequent site checks may be appropriate.

Single Patient Use SpO_2 Sensor Quick Check

1. With the sensor connected to the monitor but not applied to patient, position the sensor heads so that they face each other (the red light shines at the detector). Is "PROBE OFF" displayed on the screen?
2. Attach the Single Patient Use sensor to your index finger. Does the monitor show reasonable SpO_2 and pulse rate values?
3. A YES to BOTH #1 and #2 indicates that the sensor is working properly. Apply the sensor to the patient as instructed above. This quick check is also a functional test of the extension cable.

†Velcro is a registered trademark of Velcro USA, Inc.

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Section 5 Monitoring

Display of Data

The *CO_2SMO Plus!* measures and displays respiratory mechanics, carbon dioxide and pulse oximetry data. Until valid data is recieved for any parameter, that parameter will show a dash "--". When valid data is received, the value will display. If the parameter is lost, the value will return to dashes.

The following parameters are measured and and displayed on various screens as shown below:

DATA SET - STANDARD		
Parameter Abbreviation	**Parameter Description**	**How to Access**
$ETCO_2$	End tidal carbon dioxide	All screens except SETUP, CONFIGURATION, and DATA ENTRY.
RESP	Respiration rate	
SpO_2	Oxygen saturation	
PULSE	Pulse rate	
MV-spon MV-mech MV-total	Minute Volume for spontaneous, mechanical breaths and total.	DATA key
MV alv-spon MV alv-mech MV alv-total	Alveolar Minute Ventilation for spontaneous, mechanical breaths and total. Some literature refers to MV alv as MV eff (effective minute ventilation)	MV alv-total also found with CO_2/ PLETH key
Vt i	Inspired tidal volume	DATA key
Vt e	Expired tidal volume	
Vt alv	Alveolar tidal volume (tidal volume less airway deadspace)	
Vd aw	Airway deadspace (includes added mechanical deadspace proximal to the flow sensor)	
PIP	Peak inspiratory pressure	
MAP	Mean airway pressure (over entire breath)	
PEEP	auto PEEP	
NIP	Negative inspiratory pressure	

DATA SET - STANDARD		
RESP spon RESP mech	Respiration rate of spontaneous and mechanical breaths.	DATA key
PIF	Peak Inspiratory Flow rate	
PEF	Peak Expiratory Flow rate	
I:E	Ratio of inspiration time (ti) to expiration time (te)	
Ti	Inspiration time (time taken for inspiration portion of breaths)	
Te	Expiration time (time taken for expiration of breath)	
WOBvt	Work of breathing imposed by the breathing circuit and ventilator	
Raw i	Dynamic inspired airway resistance. Static Raw i is measured with inspiratory pause and is available in Adult mode only. STAT is displayed in place of the units.	DATA key Raw i and Cdyn also found with FLOW/PRES key.
Raw e	Dynamic expired airway resistance. Static Raw e is measured with inspiratory pause and is available in Adult mode only. STAT is displayed in place of units	
Cdyn or Cst	Dynamic compliance. Static compliance displayed with inspiratory pause	
Pplat	Pressure of the plateau during an inspiratory pause	
VCO_2	CO_2 production (volume of carbon dioxide exhaled per minute)	VCO_2 also at CO_2/ PLETH key
VCO_2/kg	CO_2 production per kilogram of body weight	
$PeCO_2$/$FeCO_2$	Mixed expired CO_2 (average expired CO_2 concentrations over the last eight breaths or one minute - whichever is less)	
C20/C (neonatal mode only)	C20/C (Dynamic compliance over the last 20% of the breath as a percentage of dynamic compliance over the total breath)	
RSBI (adult mode only)	Rapid shallow breathing index (respiratory rate divided by tidal volume)	

DATA SET - STANDARD		
Enter Weight		DATA key to ENTER/ABG WEIGHT SCREEN
Vt ml/kg mech	Tidal volume per kilogram of body weight	
Mark ABG: Event Key		
Vd/Vt phy	Deadspace (physiological) to tidal volume ratio	
Vd phy	Physiological deadspace	
Vd alv	Alveolar deadspace	

DATA SET - PROTOCOL			
Parameter Abbreviation		**Parameter Description**	**How to Access**
$ETCO_2$ *	Averaged	End tidal carbon dioxide	All screens except SETUP, CONFIGURATION and DATA ENTRY
INSP CO_2 *	Averaged	Inspired carbon dioxide	
RESP *	Averaged	Respiratory rate	RESP also at DATA key
SpO_2 *	Averaged	Oxygen saturation	
Pulse Rate *	Averaged	Pulse rate	
PEEP *		Positive end expiratory pressure. AUTO will display in place of the units whenever Auto PEEP is detected (intrinsic).	DATA key SETUP screen PEEP also at FLOW/PRES key
PIP *		Peak inspiratory pressure	
NIP		Negative inspiratory pressure	NIP also at WEANING DATA screen
VCO_2 *	Averaged	CO_2 production (volume of carbon dioxide exhaled per minute)	VCO_2 also at CO_2/PLETH key, TREND key, MONITORING and WEANING DATA screen
Vt alv mech *	Averaged		Vt alv mech also at TREND key
I:E		Ratio of inspiratory time (ti) to expiration time (te)	

DATA SET - PROTOCOL			
Raw i * Static Raw i is measured with inspiratory pause and is available in Adult mode only. STAT is displayed in place of the units		Dynamic inspired airway resistance	DATA key MONITORING screen
Raw e * Static Raw e is measured with inspiratory pause and is available in Adult mode only. STAT is displayed in place of units		Dynamic expired airway resistance	
Cdyn * Static compliance displayed with inspiratory pause		Dynamic compliance	Cdyn also at FLOW/ PRES key
VCO_2	Averaged	CO_2 production (volume of carbon dioxide exhaled per minute	VCO_2 also at CO_2 PLETH key, TREND key, SETUP and WEANING DATA screen
Vd/Vt phy (only updated when a $PaCO_2$ is entered)		Physiologic deadspace to tidal volume ratio	
PEF *		Peak expiratory flow rate	PEF also at FLOW/PRES key
Vt alv spon ml/kg*	Averaged	Spontaneous alveolar tidal volume divided by body weight	DATA key WEANING screen
Vt alv mech ml/kg*	Averaged	Mechanical alveolar tidal volume divided by body weight	
MV alv tot *	Averaged	Total alveolar minute volume	MV alv total also at TREND key
VCO_2	Averaged	CO_2 production (volume of carbon dioxide exhaled per minute)	VCO_2 also at CO_2/ PLETH key, TREND key, SETUP and MONITORING DATA screen
RSBI (adult mode only)		Rapid shallow breathing index (respiratory rate divided by tidal volume)	
C20/C (neonatel mode only)		C20/C (Dynamic compliance over the last 20% of the breath as a percentage of dynamic compliance over the total breath)	
NIP		Negative pressure	NIP also at SETUP DATA screen

DATA SET - PROTOCOL			
			DATA key
MV spon *		Spontaneous minute volume	
MV mech *		Mechanical minute volume	
MV total *		Total minute volume	
Vd aw		Airway deadspace	Also at TREND key
RESP spon *		Spontaneous respiratory rate	
RESP mech *		Mechanical respiratory rate	
Vt i		Inspired single breath tidal volume	Also at FLOW/PRES key
Vt e		Expired single breath tidal volume	
			DATA key
MAP *		Mean airway pressure	Also at FLOW/PRES key
Pplat - (adult mode only)		Pressure of the plateau during an inspiratory pause	
Ti		Inspiratory time	
Te		Expiratory time	
PIF		Peak inspiratory flow	
$PeCO_2$ /$FeCO_2$ *	Averaged	Mixed expired CO_2 (averaged expired CO_2 concentration over the last eight breaths or one minute, whichever is less)	
VCO_2 /kg	Averaged	CO_2 production per kilogram of body weight	
WOBvt		Work of breathing imposed by the breathing circuit and ventilator	
			DATA key DATA ENTRY page
ENTER WEIGHT			
Vt ml/kg mech (requires patient weight entry)		Tidal volume per kilogram of body weight	
MARK ABG: EVENT KEY			
Vd/Vt phy (requires $PaCO_2$ entry)		Physiologic deadspace to tidal volume ratio	Also at DATA key MONITORING screen
Vd phy (requires $PaCO_2$ entry)		Physiologic deadspace	
Vd alv (requires $PaCO_2$ entry)		Alveolar deadspace	

* An asterisk next to a parameter abbreviation denotes that the parameter is trended in *CO_2SMO Plus!* and that the trend is downloaded to *CO_2SMO Plus!* for Windows.

Parameters not displayed

In addition to the parameters listed above, the following parameters are also calculated and communicated through the RS232 output for display on a PC but are not displayed on the *CO_2SMO Plus!* screen:

Parameter Abbreviation		Parameter Description	How to Access
Ctot		Total compliance	Available via the optional PC-based *CO2SMO Plus!* for Windows program.
MV alv mech *	Averaged	Mechanical alveolar minute volume (Standard data set only)	
MV alv spon *	Averaged	Spontaneous alveolar minute volume (Standard data set only)	
P 0.1		Pressure at first 100 milliseconds of inspiration	
Slope of phase II		Slope of phase II of the capnogram	
Slope of phase III		Slope of phase III of the capnogram	
Vd/Vt airway	Averaged	Airway deadspace to tidal volume ratio	
Vt alv spon *	Averaged	Spontaneous alveolar tidal volume	
Vt exp mech *	Averaged	Mechanical expired tidal volume	
Vt exp spon *	Averaged	Spontaneous expired tidal volume	
Vt insp mech	Averaged	Mechanical inspired tidal volume	
Vt insp spon	Averaged	Spontaneous inspired tidal volume	
WOB imp		Imposed work of breathing	

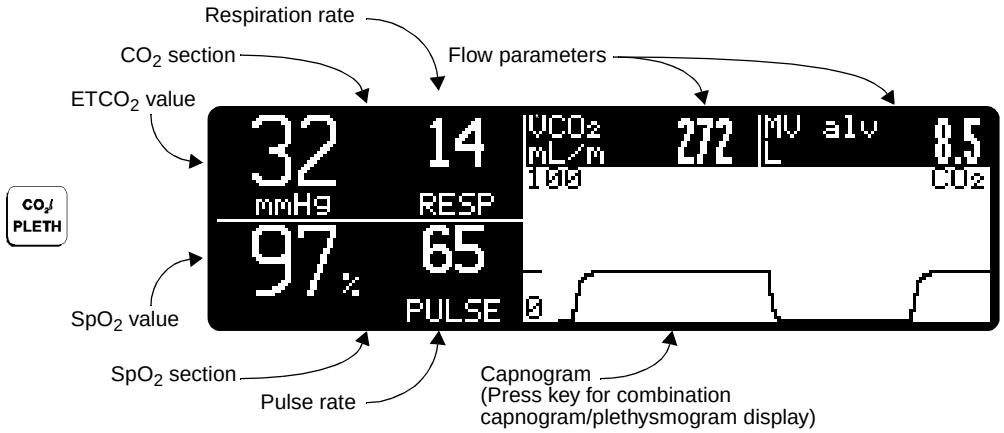
NOTE

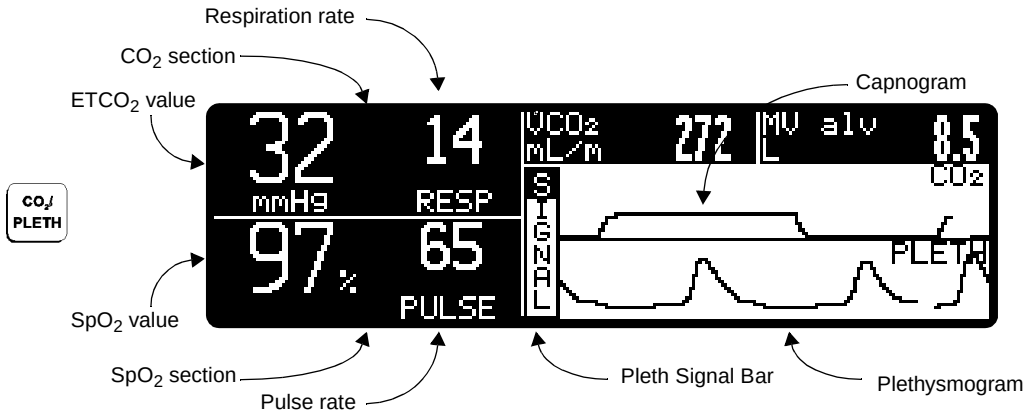
CO_2, respiratory rate and the capnogram are the only data available when using the CAPNOSTAT CO_2 sensor with the sampling airway adapter.

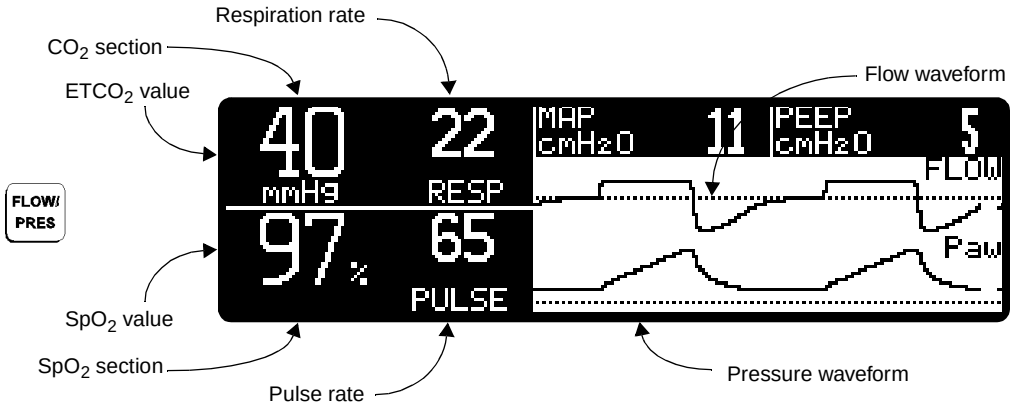
Screen Displays

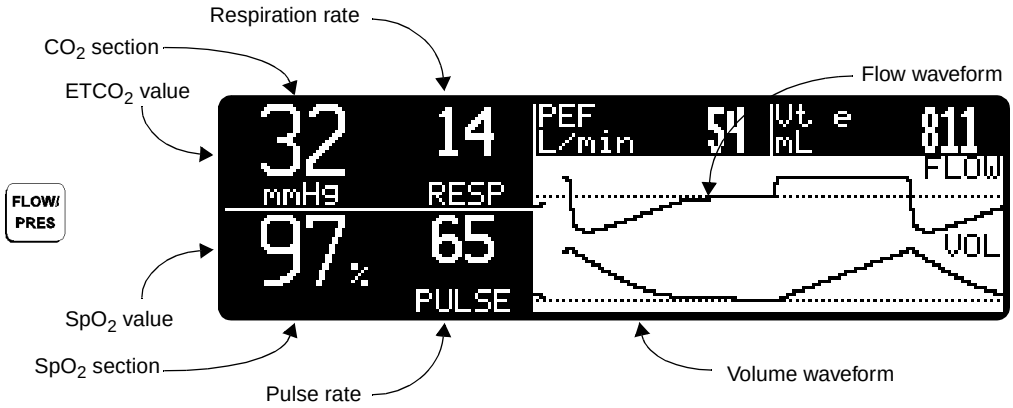
The following screens are displayed on the *CO_2SMO Plus!*:

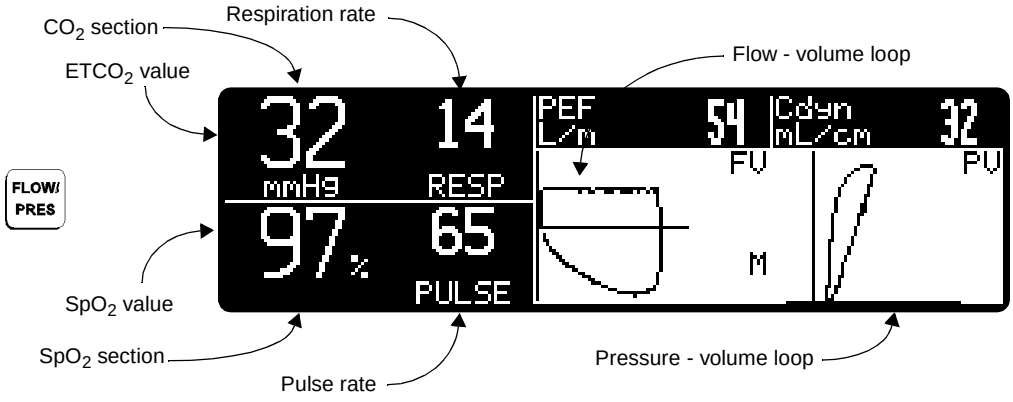
Waveform Screens







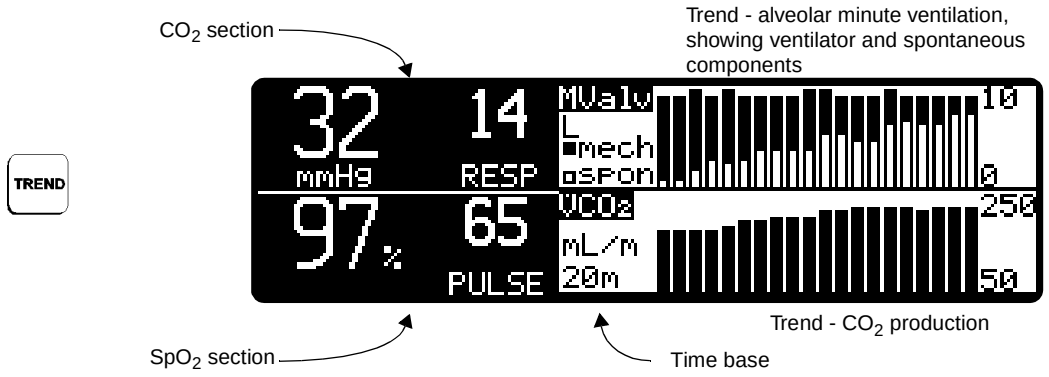


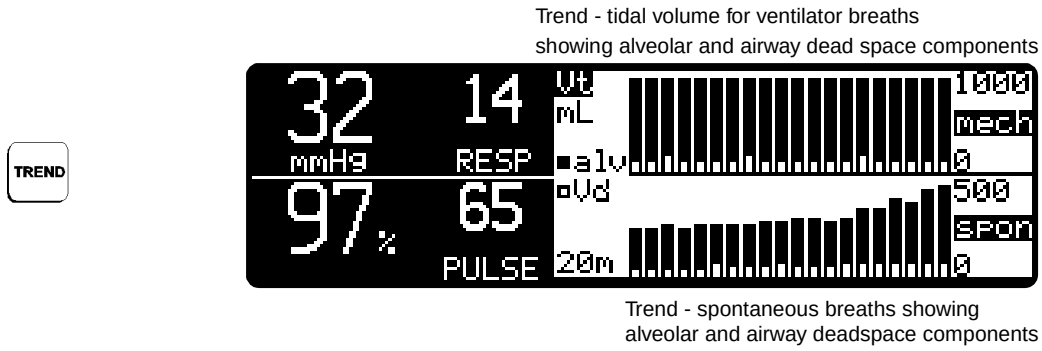


Refer to SCALE setting in the CONFIGURATION screen (see “Configuration Settings” on page 19) to display or hide scales, and for manual or automatic scale adjustment.

Trend Screens

On-screen trends are displayed as bar graphs, with 20 bars each. Using the NEXT key, the time base can be selected for 20 minutes, 1, 4, 8, 12, or 24 hours. The value of each bar is the average value in the corresponding time interval. For example, each bar in a 20 minute trend corresponds to one minute. New data is added on the right side of the screen.





Trend Memory

In addition to on-screen trends, the *CO_2SMO Plus!* has internal trend memory that stores up to 30 calculated parameters for 24 hours at a one minute resolution (see below for trend list). These parameters are stored as the average value over the one minute period. If installed, SpO_2 is stored as the minimum over one minute. Stored parameter values can be downloaded (transferred) to a PC and viewed using the optional *CO_2SMO Plus!* for Windows PC software package from Novametrix.

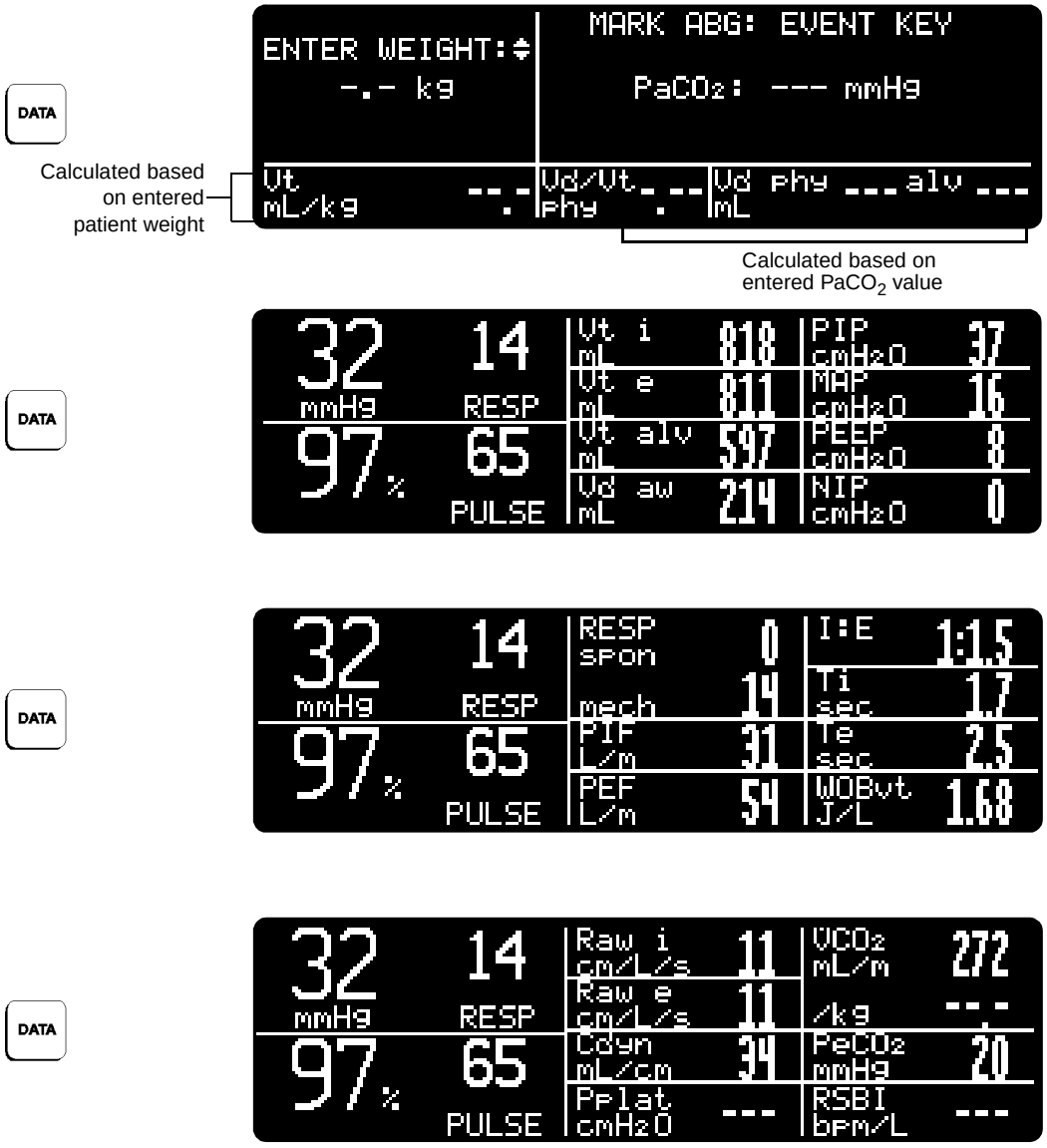
***CO2SMO Plus!* Trended Parameter List**:

- Resp rate total
- Resp rate spon
- Resp rate mech
- PEF (peak expiratory flow)
- MV total
- MV spon
- MV mech
- Cdyn (dynamic compliance)
- $PeCO_2$ (mixed expired CO_2)
- $ETCO_2$
- Insp CO_2
- VCO_2
- VT alveolar spon ml/kg
- VT alveolar mech lm/kg

- VT EXP mech (avg)
- VT EXP spon (avg)
- Raw inspired
- Raw expired
- MAP (mean airway pressure)
- PIP (peak inspiratory pressure)
- PEEP (positive end expiratory pressure
- VT alveolar spon
- VT alveolar mech
- MV alveolar total
- MV alveolar spon
- MV alveolar mech
- SpO_2
- pulse rate

Data Screens

Data Set - Standard



To enter $PaCO_2$ (for calculation of Vd/Vt phy, Vd phy, and Vd alv):

While this screen is displayed, press the EVENT/FREEZE key when a blood sample is drawn. A time and date marker will be placed below the $PaCO_2$ value. When the ABG results are known, return to this screen and use the △ ▽ keys to enter the $PaCO_2$ value. Pressing the up arrow △ once will display the $PeCO_2$ (mixed expired CO_2 value) that will be used for the calculations. When this screen is exited the $PaCO_2$ value will be locked. To enter a new ABG value press the EVENT/FREEZE key while viewing this screen.

NOTE

Vd/Vt Phy, Vd Phy, and Vd alv are calculated based on the $PaCO_2$ value last entered, and are not updated until the next time the $PaCO_2$ value is entered or changed.

To enter patient weight (for calculation of Vt/kg and VCO_2/kg):

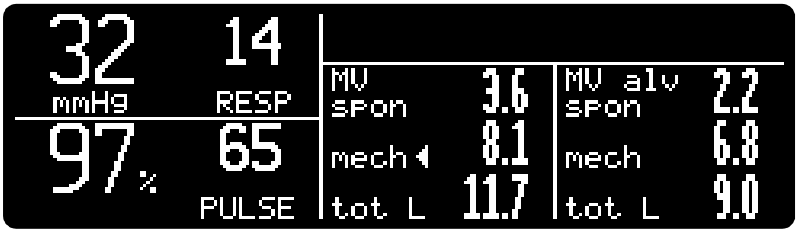
Press NEXT to move the pointer to the weight value. Use the △ ▽ keys to enter weight. A time and date marker will be placed below the weight value.

NOTE

Vt ml/kg (tidal volume per kilogram) and VCO_2/kg (CO_2 production per kilogram) are updated with every breath based on the most recently entered patient weight

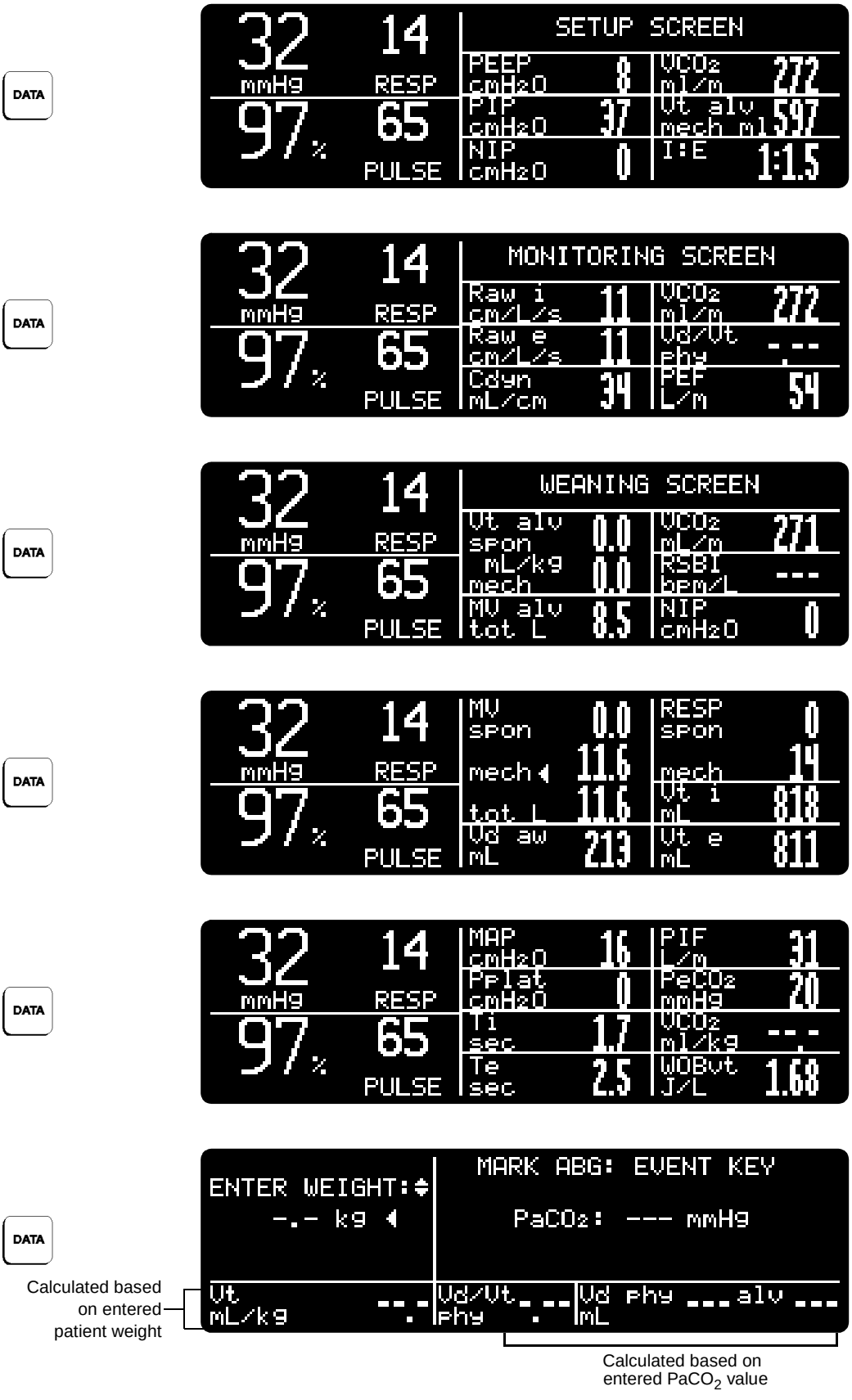
.

DATA



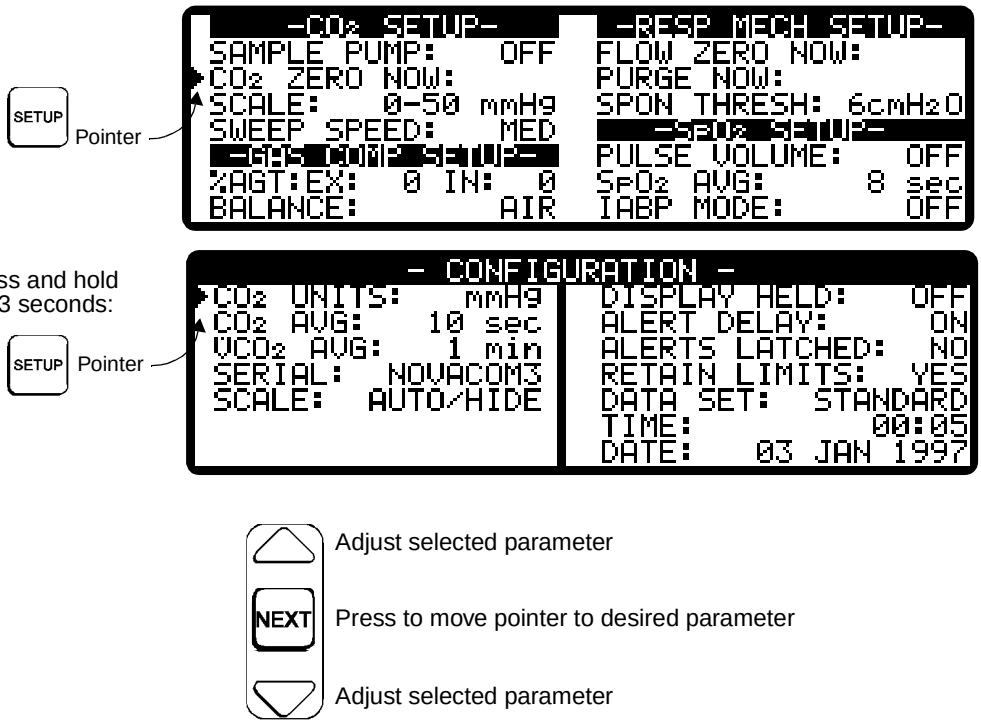
The pointer next to spon (spontaneous) or mech (mechanical) indicates the current breath type identified by the monitor.

Data Set - Protocol



Setup Screen

Refer to “Setup and Configuration Settings” on page 16 for more information.

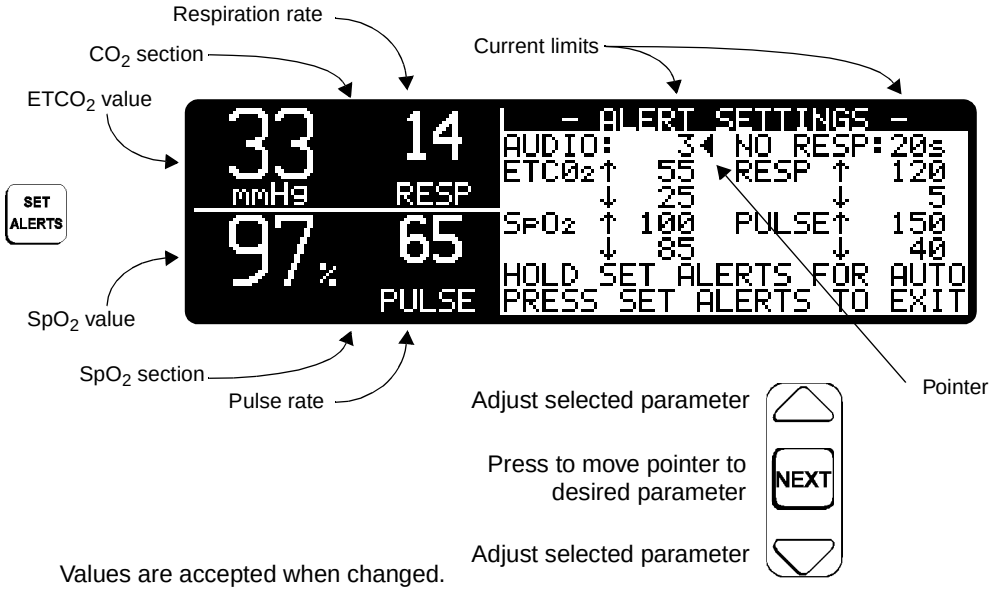


Values are accepted when changed.

Press any key to exit (pressing SETUP returns to the previous screen).

Alert Settings Screen

Refer to “Alerts and Messages” on page 73 for more information.



Values are accepted when changed.

Press any key to exit (pressing SET ALERTS returns to the previous screen).

Notes on Patient Monitoring

Flow/CO_2 Sensor Tubing Purge

The *CO_2SMO Plus!* includes an automatic and manual purge feature which provides a flow rate of room air to keep the pressure sense lines free from water condensation and patient secretions. This feature is available for the adult/pediatric and the neonatal mode.

Automatic purge - Adult/Pediatric mode

The system automatically purges the pressure sense lines every 2 minutes, 5 minutes or 10 minutes depending on system conditions. A double lumen connecting line connects the Series 3 flow/CO_2 sensor to the *CO_2SMO Plus!*. The system will purge one side of the line and then the other during each purge cycle. The frequency of the purge is primarily dependent on ventilator circuit pressure. At low circuit pressure (0-20 cmH_2O) the system will purge every 10 minutes. As circuit pressure increases (21-40 cmH_2O) the system purges every 5 minutes. When the circuit pressure is greater than 40 cmH_2O, the system purges every 2 minutes. This action anticipates increased moisture migration into the pressure sense lines due to the increase in circuit pressure.

Manual purge - Adult/Pediatric mode

Occasionally, purging may be required in between the automatic purge cycle. The manual purge may be used as often as needed, and may be used at all times **except** when a very low battery condition exists. During very low battery conditions, automatic and manual purging is not allowed.

To manually purge, press the SETUP key on the front panel. Press the NEXT key until the arrow is next to the PURGE NOW: selection. Press the up arrow △ to start the manual purge. The system will purge one side of the line and then the other during each purge cycle.

Automatic Purge - Neonatal mode

The automatic purge cycle used in the neonatal mode is fixed at every 5 minutes regardless of circuit pressure. Unlike the adult purge mode, the neonatal purge mode does not use the full force of the internal pump, but rather pressurizes an internal reservoir which is used for the purge. This minimizes the pressure delivered to the ventilator circuit, but does deliver a sufficient pressure to purge the pressure sense lines. The other significant difference in the neonatal mode is that only one side of the pressure sense line is purged during each purge cycle. The purge will only occur during the exhalation portion of the ventilator cycle, regardless of exhalation time.

Manual purge - Neonatal mode

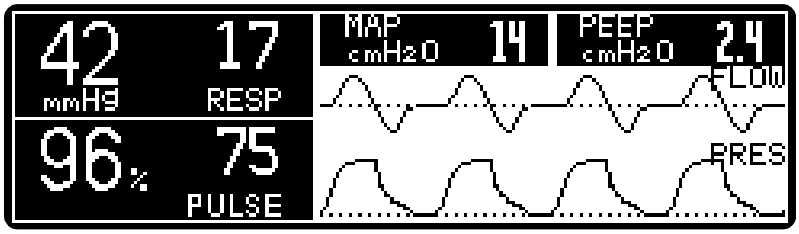
To manually purge, press the SETUP key on the front panel. Press the NEXT key until the arrow is next to the PURGE NOW: selection. Press the up arrow △ to start the manual purge. The system will purge one side of the line during each purge cycle. The purge is synchronized to the exhalation phase of the ventilator cycle and will not exceed exhalation time.

NOTE

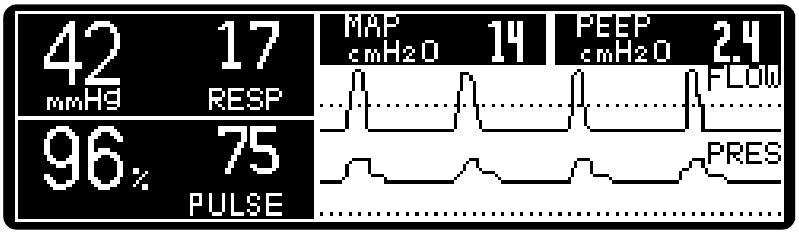
- Water that accumulates in the Neonatal Combo CO_2/Flow and Neonatal Flow Sensors or the sensor tubing may cause the reported Tidal Volumes to be higher than set volumes. If reported values are higher (or lower) than expected and water is seen in the line or sensor body, purge the lines. If purging does not clear the water, remove the sensor from the circuit and remove the water by shaking the sensor, or by flowing Oxygen or Compressed Air through the tubing or sensor until the water is removed. Do not use high pressure for water removal.
- To minimize the effects of aerosolized medications on the flow/CO_2 sensor, it is recommended that the flow/CO_2 sensor be removed from the ventilator circuit prior to the delivery of the medication. ***The decision to remove or not remove the flow/CO_2 sensor is the responsibility of the clinician.***
- During the purge cycle the pump will be heard.
- Water will condense in the pressure sense lines at a faster rate when used in cooler ambient temperatures.
- Always keep the flow/CO_2 sensor tubing pointed in an up position (position of the arrow) to minimize pooling of water and secretions at the pressure sense line openings.
- The automatic purge mode may not be disabled.
- During a very low battery condition, automatic and manual purging is not allowed.

A purge can also be initiated upon request if the flow waveform appears as though the lines are paritally occluded (see example below) and the purge did not initiate automatically.

Normal



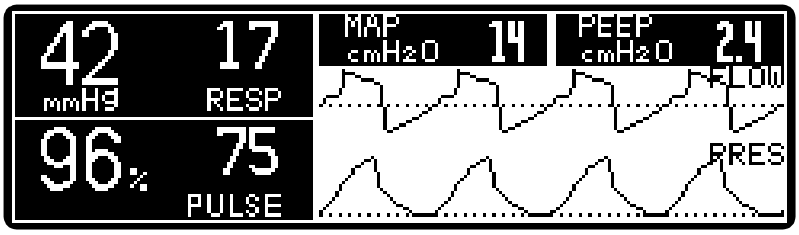
Occluded



To initiate a purge, Press SETUP, then NEXT until the pointer is next to PURGE NOW, then press the ⌓ key. NOTE: If the purge does not sufficiently clear the flow tubing lines, the flow sensor should be changed.

Below is an example of a waveform that exhibits a small leak in the flow sensor tubing. Replace flow sensor; if problem persists, refer monitor to qualified service personnel.

Small leak in flow tubing



Flow Sensor Zeroing

The systems ability to maintain a flow zero reference during all monitoring conditions is controlled by the automatic and manual flow zero feature. The frequency of the automatic flow zero depends on monitoring conditions and whether you are in the adult/pediatric or neonatal mode. In either the automatic or manual mode, the flow sensor zero takes no longer than 2 to 3 seconds.

Automatic flow zero - Adult/Pediatric mode

When the *CO_2SMO Plus!* is placed into the operate mode from a cold start, the internal temperature of the system will gradually warm to its nominal operating temperature. During this period, a flow sensor zero will occur approximately once per minute. As the temperature reaches nominal, the frequency of the flow sensor zero increases to every 10 minutes. If the *CO_2SMO Plus!* is placed into operation from the standby mode, the flow sensor zero will occur every 10 minutes since the *CO_2SMO Plus!* is already at its nominal temperature. Also, a flow sensor zero will occur after every automatic or manual purge.

Manual flow zero - Adult/Pediatric mode

A manual flow sensor zero may be used if a positive or negative offset of the flow waveform from zero baseline is observed. This condition mainly occurs if the orientation of the *CO_2SMO Plus!* has changed since the last flow sensor zero.

To manually zero the system, press the SETUP key on the front panel of the *CO_2SMO Plus!* then press the NEXT key until the pointer is next to FLOW ZERO NOW:. Press the up arrow △ to initiate a flow zero. There is no message to alert you that the flow zero has occurred while viewing the SETUP screen. Press the FLOW/PRES key to return to the flow waveform screen and observe the flow waveform. If the offset has not been corrected, repeat the procedure. If the offset does not clear after another flow sensor zero, replace the flow sensor with a new one and observe the flow waveform. If the offset is still present, contact your biomedical engineering department.

Automatic flow zero - Neonatal mode

The automatic flow sensor zero occurs under the same conditions as the adult, but in the neonatal mode, the automatic flow sensor zero occurs every 30 seconds during the warming period and changes to every 3 minutes when the nominal temperature is reached. A flow sensor zero occurs after every purge cycle.

Manual flow zero - Neonatal mode

A manual flow sensor zero may be used if a positive or negative offset of the flow waveform from zero baseline is observed. This condition mainly occurs if the orientation of the *CO_2SMO Plus!* has changed since the last flow sensor zero.

To manually zero the system, press the SETUP key on the front panel of the *CO_2SMO Plus!* then press the NEXT key until the pointer is next to FLOW ZERO NOW:. Press the up arrow △ to initiate a flow zero. There is no message to alert you that the flow zero has occurred while viewing the SETUP screen. Press the FLOW/PRES key to return to the flow waveform screen and observe the flow waveform. If the offset has not been corrected, repeat the procedure. If the offset does not clear after another flow sensor zero, replace the flow sensor with a new one and observe the flow waveform. If the offset is still present, contact your biomedical engineering department.

Intra-Aorta Blood Pump

See “IABP MODE” in “Setup and Configuration Settings” on page 16 for SpO_2 and pulse rate calculations when using an intra-aortic balloon pump.

Reference Handbooks

For a discussion on waveform interpretations, refer to the Novametrix Reference Handbooks on capnography, respiratory mechanics, and pulse oximetry. Contact Novametrix Customer Service or your local sales representative for more information.

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Section 6 HP VueLink Interface

The *CO_2SMO Plus!* interface to the Hewlett Packard VueLink module provides a pathway for *CO_2SMO Plus!* data to be viewed on the Hewlett Packard Patient Monitoring System. Twenty eight parameters and five waveforms are transmitted to the Hewlett Packard Patient Monitor. These are available for display in conjunction with the other parameters configured for display on the Hewlett Packard Patient Monitor.

Transmitted Parameters

Parameter	Label	Units
Dynamic Compliance	Cdyn	ml/cmH_2O
Inspired Airway Resistance (Dynamic)	RAW i	cmH_2O/L/S
Expired Airway Resistance (Dynamic)	RAW e	cmH_2O/L/S
Peak Inspiratory Pressure	PIP	cmH_2O
Positive End Expiratory Pressure	PEEP	cmH_2O
Mean Airway Pressure	Pmean	cmH_2O
Pulse Rate	Pulse	bpm
SpO_2	SpO_2	%
$ETCO_2$	$ETCO_2$	mmHg, %, kPa
Respiratory Rate	AWRR	rpm
Peak Expiratory Flow	PEF	L/min
Inspired Tidal Volume	TVin	ml
Expired Tidal Volume	TVex	ml
Total Minute Volume	MVt	L
Spontaneous Minute Volume	MVs	L
Mechanical Minute Volume	MVm	L
CO_2 Production	VCO_2	ml/min
Mixed Expired CO_2	$PECO_2$	mmHg
Airway Deadspace	VD aw	ml
Physiologic deadspace to tidal volume ratio	VdVtPh	

Total Alveolar Tidal Volume	VT alv t	ml
Spontaneous Alveolar Tidal Volume	VT alv s	ml
Mechanical Alveolar Tidal Volume	VT alv m	ml
Alveolar Minute Volume (Total)	MV alv	L

Transmitted Waveforms

Waveform	**Label**	**Units**
Airway Flow	AWF	L
Volume	AWV	ml
Airway Pressure	AWP	cmH_2O
CO_2 Capnogram	CO_2	mmHg, %, kPa
Plethysmogram	PLETH	N/A

Preparing for Use

This section details the setup and connection of the *CO_2SMO Plus!* to the Hewlett Packard VueLink module.

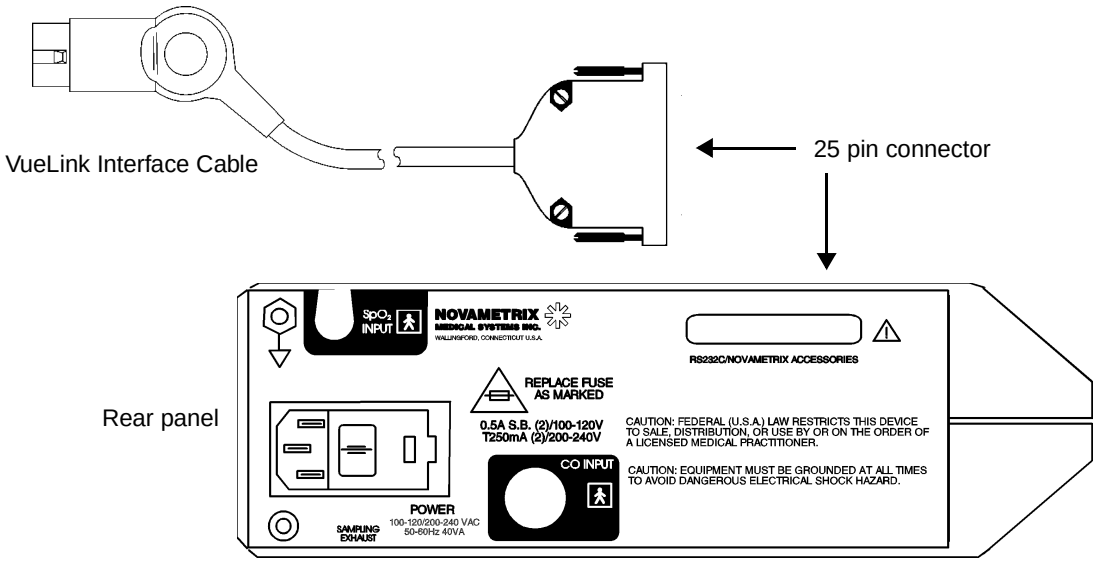
To prepare the *CO_2SMO Plus!* for operation you will need the following:

- *CO_2SMO Plus!* with software revision 2.0 or greater, part number 6758-00
- *CO_2SMO Plus!* VueLink Adapter, Novametrix part number 550034
- Hewlett Packard Patient Monitor with software revision C (9.xx) or higher.
- Hewlett Packard VueLink module, Auxiliary Plus B with Open Interface (product number M1032 option A05).
- Hewlett Packard 4 meter VueLink to *CO_2SMO Plus!* Interface Cable (part number K6B)

NOTE: The Hewlett Packard Patient Monitor, VueLink Module and Hewlett Packard interface cable are supplied by Hewlett Packard.

Component Setup

1. Connect the CAPNOSTAT, flow sensor, pulse oximeter probe and AC power cord as described in Sections 3 and 4 of this User's Manual
2. Connect the 25 pin male connector on the VueLink Interface Cable to the 25 pin female connector on the rear panel of the *CO_2SMO Plus!*. Tighten screws. Connect the other end of the cable to the VueLink module by grasping the end of the connector and pushing it into the receptacle on the VueLink module..


VueLink Interface Cable
25 pin connector
Rear panel
SpO2 INPUT
NOVAMETRIX
MEDICAL SYSTEMS INC.
WALLINGFORD, CONNECTICUT U.S.A.
RS232C/NOVAMETRIX ACCESSORIES
REPLACE FUSE AS MARKED
0.5A S.B. (2)/100-120V
T250mA (2)/200-240V
CAUTION: FEDERAL (U.S.A.) LAW RESTRICTS THIS DEVICE TO SALE, DISTRIBUTION, OR USE BY OR ON THE ORDER OF A LICENSED MEDICAL PRACTITIONER.
CO INPUT
CAUTION: EQUIPMENT MUST BE GROUNDED AT ALL TIMES TO AVOID DANGEROUS ELECTRICAL SHOCK HAZARD.
POWER
100-120/200-240 VAC
50-60Hz 40VA
SAMPLING EXHAUST

3. Power up the *CO_2SMO Plus!* by setting the rear panel power switch to ON (|) and pressing the power key.
4. Press and hold the SETUP key on the front of the *CO_2SMO Plus!* until the CONFIGURATION menu appears.
5. Press the NEXT key until the arrow is pointing to the SERIAL selection.
6. Press the ▲ ▼ up or down arrow to cycle through the selections until the VUELINK selection appears.
7. Press any key to leave the CONFIGURATION menu. The serial output of the *CO_2SMO Plus!* is now set to communicate to the VueLink module.
8. Plug the VueLink Module into an available slot in the Hewlett Packard monitoring system module rack.
9. After 30 seconds, the selected waveforms and parameters will appear on the display.

   NOTE: If you need detailed installation and operating instructions for the Hewlett Packard VueLink Module and the Hewlett Packard Patient Monitor, refer to the Hewlett Packard Operator's Manual.

Module Setup

A total of 28 parameters are trended in the *CO_2SMO Plus!* unit; 17 of these parameters can be transmitted to the Hewlett Packard Patient Monitor. From this list of 17 pre-selected parameters (shown below), you may choose up to 6 for display on the HP Main Screen.

Pre-selected Parameters

Parameter	**Label**	**Units**
Dynamic Compliance	Cdyn	ml/cmH_2O
Inspired Airway Resistance (Dynamic)	RAW i	cmH_2O/L/S
Expired Airway Resistance (Dynamic)	RAW e	cmH_2O/L/S
Peak Inspiratory Pressure	PIP	cmH_2O
Positive End Expiratory Pressure	PEEP	cmH_2O
Pulse Rate	Pulse	bpm
SpO_2	SpO_2	%
$ETCO_2$	$ETCO_2$	mmHg, %, kPa
Respiratory Rate	AWRR	rpm
Expired Tidal Volume	TVex	ml
Total Minute Volume	MVt	L
CO_2 Production	VCO_2	ml/min
Mixed Expired CO_2	$PECO_2$	mmHg
Airway Deadspace	VD aw	ml
Physiologic deadspace to tidal volume ratio	VdVt Ph	
Total Alveolar Tidal Volume	VT alv t	ml
Alveolar Minute Volume (Total)	MV alv	L

Auxiliary Plus Task Window

Press the **VueLink** button on the VueLink module; or press the **Module Setup** key on the front of the Hewlett Packard Patient Monitor, then press the softkey under the *CO_2SMO Plus!* selection of the menu. Either action brings up the Auxiliary Plus window. This window lists all of the transmitted parameters and has additional menu selections that allow for the module setup.

Scale Wave - This selection allows you to set the scales for the waveforms. When selected, the parameter table in the Auxiliary Plus window will clear and the available scale settings for the waveform currently being viewed in the Auxiliary Plus window will be displayed. You may select the desired waveform scale by using the lighted right or left arrow keys on the front of the Hewlett Packard monitor. When the scale is selected, press the **Module Setup** key to return you to the Auxiliary Plus window or press the **Main Screen** key to return you to the Main Display.

Waveform Scale Selections:

Flow (AWF)	100, 50, 25 Liters per minute
Pressure (AWP)	60, 30, 15 cmH_2O
Tidal Volume (AWV)	2000, 1000, 500 ml
CO_2	100, 50, 25 mmHg
Plethysmogram	none

Next Wave - A total of five (5) *CO_2SMO Plus!* waveforms are transmitted. Up to two waveforms may be displayed on the Hewlett Packard Patient Monitor Main Screen at one time. One of these waveforms will be displayed in the Auxiliary Plus window. You may toggle between the two selected waveforms by pressing the **Next Wave** softkey, while viewing the Auxiliary Plus window.

Freeze Values - When selected, the parameters in the Auxiliary Plus window are frozen. The waveform is not. The values displayed on the Main Screen are not frozen.

Update Values - When selected, the parameters in the Auxiliary Plus window resume updating.

Select Device - When selected, a list of devices available with the VueLink module that you are using will display. Refer to the Hewlett Packard Operator's Manual for further information.

Select Data - This softkey is used to select the waveforms and parameters you want displayed on the monitor. Pressing Select Data opens an Auxiliary Plus window with the waveforms listed on the left and the parameters listed on the right.

If you have chosen two waveforms, they are listed as Wave 1 and Wave 2 and show the waveform label that has been selected for that waveform slot along with a color block for that waveform. The Number slots 1 through 6 are listed along with the parameters that they have been assigned (the six parameters chosen above).

To change a waveform or parameter:

1. Press the **Module Setup** key.
2. Press the *CO_2SMO Plus!* softkey. An Auxiliary Plus window opens.
3. Press the **Select Data** softkey.
4. Press the **Next Channel** softkey, or press any of the lighted arrow keys to cycle through the list until you get to the waveform or parameter that you wish to change.
5. When you have reached the waveform or parameter that you want to change, press the **Select Signal** softkey.
6. If you are changing a waveform, a list of the available waveforms will appear. If you are changing a parameter, a list of available parameters will appear. You may not select the same waveform for both waveform slots and you may not display a parameter twice.

7. You may select a new waveform by pressing the lighted right or left arrow key until you get to the desired selection. You may select a new parameter by pressing any of the lighted arrow keys until you get to the desired selection.
8. When you have made the changes that you want, select the **Main Screen** key to return to the Main Screen, or press the **Module Setup** key to return to the Auxiliary Plus window.

Trends/Calcs

The parameters that are selected for display will be trended in tabular and graphical format by the Hewlett Packard Patient Monitor. Select one type of display from the HP menu.

Vital Signs Trends

1. To open the Vital Signs window, press the **Trends/Calcs** key on the front of the Hewlett Packard patient monitor.
2. From the Trends/Calcs menu, press the **Vital Signs** softkey.
3. The Vital Signs window appears.
4. The Vital Signs window menu selections are:

   Next Page - Use this selection to cycle through the vital signs pages.

   On/Off Graph - This key selects the parameters that you want to graphically trend. Use the lighted up or down arrow keys to cycle through the parameters that you want to graphically trend, then select the **On/Off Graph** softkey to add a parameter to the graph trend list or remove the parameter from the graph trend list. Up to 3 of the 6 parameters shown on the Main Screen may be graphically trended.

   Zoom In - This selection increases the trend resolution.

   - Press the **Zoom In** softkey once and the resolution increases to every 15 minutes.
   - Press the **Zoom In** softkey twice and the resolution increases to every 5 minutes.
   - Press the **Zoom In** softkey three times and the resolution increases to every minute.

   Zoom Out - This selection decreases the trend resolution.

   - Press the **Zoom In** softkey once and the resolution decreases to every 15 minutes.
   - Press the **Zoom In** softkey twice and the resolution decreases to every 5 minutes.
   - Press the **Zoom In** softkey three times and the resolution decreases to every minute.

   Print Vitals - Prints the trended vital signs. Refer to the Hewlett Packard Operator's Manual for more information on printing.

   Graph Trends - This selection brings up the Graph Trends window.

Graphical Trends

1. To open the Graphical Trends window, press the **Graph Trends** softkey from the Vital Signs screen.
2. The Graphical Trends window menu selections are:

   Next Graphs - Use this selection to cycle through the Graphical Trends pages.

   Zoom In - This selection increases the trend resolution. The zoom feature uses the Vertical Time Bar as the marker for the point in time that you wish to zoom.

Pressing the **Zoom In** softkey will increase the resolution of the trend graph in increments of one-half hour, 1 hour, 2 hours and 3 hours.

Zoom Out - This selection decreases the trend resolution. The zoom feature uses the Vertical Time Bar as the marker for the point in time that you wish to view.

Pressing the **Zoom Out** softkey will decrease the resolution of the trend graph in increments of one-half hour, 1 hour, 2 hours and 3 hours.

Change Scale - This selection changes the scale of the graphic trends.

Vital Signs - Pressing this softkey returns you to the Vital Signs trend window.

Alarms and Messages

Alarms and messages are not transmitted from the *CO_2SMO Plus!* unit to the Hewlett Packard VueLink module. All alarms and messages must be viewed directly from the *CO_2SMO Plus!*

To Stop Monitoring with the CO_2SMO Plus!

1. Press the power key on the front panel of the *CO_2SMO Plus!*.
2. The *CO_2SMO Plus!* screen will clear and the screen will turn off.
3. The *CO_2SMO Plus!* data will clear from the screen of the Hewlett Packard patient monitor.
4. The VueLink Module may be left in the HP monitoring system module rack.

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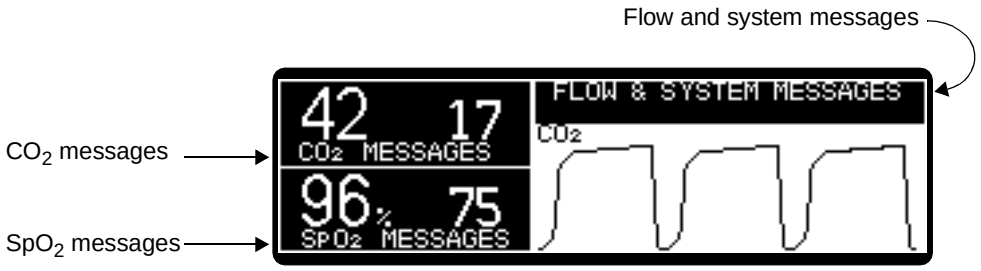
Section 7 *Alerts and Messages*

Alerts

Alerts are generated for $ETCO_2$, respiration rate, SpO_2, and pulse rate. These alerts occur when the limits for a particular parameter are exceeded. There is also an alert when there is a loss of respiration for a consecutive twenty seconds (other limit times may be selected, see "Manually Setting Alert Limits" on page 80). The NO RESPIRATION alert is not generated when both the CAPNOSTAT CO_2 sensor and the flow sensor are disconnected from the *CO_2SMO Plus!*. Alert messages are displayed in the message center or in the particular area of the display when they occur. For example a CO_2 message will be displayed in the CO_2 section of the screen.



Status messages indicate conditions that should be corrected or monitored; they may or may not be tied to an alert condition. Status messages are displayed on the screen in the same manner as alert messages. Following is a list of status messages that may appear on the monitor.

System Messages

Message	**Meaning of message**
AUDIO OFF DISABLED	The "AUDIO OFF" feature is disabled by choice of the institution.
AUTO ALERT LIMITS SET	This message is displayed when the monitor has successfully determined and set the auto alert limits for SpO_2, pulse rate, $ETCO_2$ and respiratory rate.
BAROMETRIC PRESSURE ERROR	Barometric pressure is out of range (400-800 torr).
BATTERY VERY LOW PLUG IN AC POWER	Battery power has been depleted and the monitor will shut off shortly.

Message	**Meaning of message**
ERASE STORED TRENDS? YES: △ NO: ▽	This prompt appears each time the monitor is turned on. To erase stored trends press △. To keep stored trends press ▽, or allow the message to time out, or press any other key.
EVENT MARKER	This message appears in the message center when the EVENT/FREEZE key is pressed.
INSUFFICIENT DATA TO MARK ABG EVENT	The monitor will not allow an ABG event to be marked when data such as $PeCO_2$ or tidal volume is not available.
NOT ENOUGH DATA TO SET $ETCO_2$ LIMITS	This message is displayed when the monitor could not successfully determine the auto alert limits for $ETCO_2$.
NOT ENOUGH DATA TO SET $ETCO_2$ & RR LIMITS	This message is displayed when the monitor could not successfully determine the auto alert limits for $ETCO_2$ and respiratory rate.
NOT ENOUGH DATA TO SET $ETCO_2$ & SpO_2 LIMITS	This message is displayed when the monitor could not successfully determined the auto alert limits for $ETCO_2$ and SpO_2.
NOT ENOUGH DATA TO SET $ETCO_2$, SpO_2 & RR LIMITS	This message is displayed when the monitor could not successfully determined the auto alert limits for $ETCO_2$, SpO_2 and respiratory rate.
NOT ENOUGH DATA TO SET SpO_2 LIMITS	This message is displayed when the monitor could not successfully determine the auto alert limits for SpO_2.
NOT ENOUGH DATA TO SET SpO_2 & RR LIMITS	This message is displayed when the monitor could not successfully determine the auto alert limits for SpO_2 and respiration rate.
NOT ENOUGH DATA TO SET RR LIMITS	This message is displayed when the monitor could not successfully determine the auto alert limits for respiration rate.
SETTINGS RESET TO FACTORY DEFAULTS	All setup and alert settings have just been reset to factory default values.
TRENDS ERASED	The trends stored in the monitor's memory have been erased.
TRENDS RETAINED	The trends in the monitor's memory have not been erased. New trend data will be appended to the currently stored data.
WARNING! CHECK TIME/DATE (HOLD SETUP KEY)	Time and date may not be properly set. The time and date can be adjusted in the CONFIGURATION screen (accessed by holding the SETUP key for three seconds.)
WAVEFORM FROZEN UNFREEZE:PRESS EVENT KEY	This message appears in the message center when the EVENT/FREEZE key is pressed while displaying waveforms or loops.

Respiratory Mechanics (Flow) Messages

Message	Meaning of message
ADULT FLOW SENSOR IDENTIFIED	Optical encoders identified that a Pediatric/Adult Flow Sensor is connected.
ADULT FLOW/CO2 SENSOR IDENTIFIED	Optical encoders identified that a Pediatric/Adult Flow/CO_2 Sensor is connected.
AIRWAY PRESSURE ZERO ERROR	Airway pressure transducer detects an error.
NO SENSOR CONNECTED	Optical encoders identified that flow sensor is not connected.
FLOW SENSOR ZERO ERROR	Flow sensor pressure transducer was not able to be zeroed.
NEONATAL FLOW SENSOR IDENTIFIED	Optical encoders identified that a Neonatal Flow Sensor is connected.
NEONATAL FLOW/CO2 SENSOR IDENTIFIED	Optical encoders identified that a Neonatal Flow/CO_2 Sensor is connected.
PURGING	The monitor is attempting to clear the flow sensor tubing.
INCOMPATIBLE FLOW SENSOR	Optical encoders identified that an incompatible flow sensor is connected.
FLOW ZERO IN PROGRESS	Displayed while a flow sensor zero is in progress.
PRESS NEXT KEY TO RESCALE	Appears when the SCALE selection from the CONFIGURATION screen is set to MAN/SHOW and the loops, flow/pressure waveforms require rescaling.

Oxygen Saturation Messages

Message	Meaning of message
AMBIENT LIGHT COVER PROBE OR CHANGE SITE	Interference due to ambient lighting conditions is detected (bright room lights, heat lamps, billilights).
BAD SPO_2 SIGNAL CHECK PROBE OR CHANGE SITE	Not enough light signal is being detected by the SpO_2 probe's photodetector. Try applying the probe to a different location. An acceptable pulse signal could not be detected.
FAULTY PROBE	The SpO_2 probe, or extension cable (if used) needs to be replaced.
LOW LIGHT CHANGE SITE	Not enough light signal is being detected by the SpO_2 probe's photodetector. Try applying the probe to a different location.
LOW SpO_2 SIGNAL	The SpO_2 signal is low, this could be due to poor sensor placement or low perfusion.

Message	Meaning of message
PROBE OFF	The SpO_2 probe is off the patient.
PULSE OUT OF RANGE	The pulse rate is beyond the measurement range of the monitor (30-250 beats/min).
SpO_2 HDW ERROR	An error with the monitor's internal circuitry has been detected. Refer servicing to qualified personnel.
SPO_2 PROBE?	SpO_2 probe is disconnected or damaged.
SpO_2 SEARCH: XX	The monitor is currently searching for an acceptable pulse signal. The XX will indicate in seconds the duration of the search.

Capnography Messages

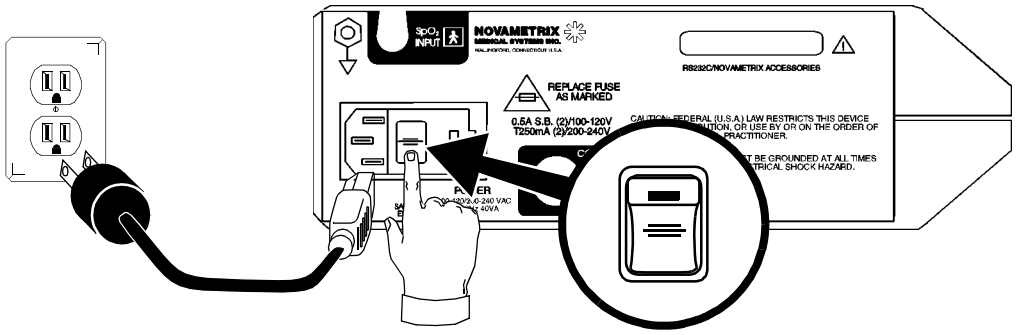
Message	Meaning of message
ATTACH CANNULA AND SAMPLE ROOM AIR OK: △ CANCEL: ▽	Pump was just turned on (or pump was already on and an adapter zero is required), or pump was already on and a zero was manually requested.
BREATH DETECTED	A changing level of CO_2 was detected during an adapter zero procedure.
SENSOR PASSED	CAPNOSTAT CO_2 sensor is within acceptable calibration limits.
CAN'T ZERO CHANGE SENSOR OR CALL SERVICE	An error has occurred during a CO_2 zero. Refer servicing to qualified personnel.
CHECK ADAPTER HELP: PRESS △	Excessive moisture or secretions detected in the adapter. Adapter type has been changed (e.g. reusable to single patient use). No adapter detected.
CHECKING ON CELL	CAPNOSTAT CO_2 sensor is currently on the reference cell.
CO_2 OVER-TEMP	The CAPNOSTAT CO_2 sensor's temperature is above normal operating temperature.
CO_2 SENSOR?	CAPNOSTAT CO_2 sensor not connected to the monitor or is damaged.
CO_2 WARM-UP	CAPNOSTAT CO_2 sensor has not reached the required temperature.
PLEASE WAIT FOR SENSOR CANCEL: PRESS ▽	The CAPNOSTAT CO_2 sensor has not reached operating temperature while attempting to zero.

Message	**Meaning of message**
$ETCO_2$ OUT OF RANGE	The detected $ETCO_2$ value is beyond the measurement range of the monitor (0-100mmHg, 0-12.5% or kPa).
FAULTY SENSOR: X	CAPNOSTAT CO_2 sensor needs servicing (X = service code)
GAS COMP	Gas compensation (SETUP screen) is set to a value other than zero percent anesthetic agent and room air balance (GAS COMP message replaces RESP label)
INSP. CO_2: XX.X	An inspired CO_2 level of 3mmHg (or 0.4% or kPa) was detected for 15 consecutive seconds.
PUT ON -0- CELL	Place the CAPNOSTAT CO_2 sensor on the -0- (zero) cell located on the sensor cable.
NO RESP: XX	A breath has not been detected for the indicated time (XX seconds). This message appears when the time since the end of expiration of the last detected breath exceeds the NO RESP time setting in the SET ALERTS screen.
NOT CALIBRATED PUT ON -0- CELL	A cell zero (cable -0- cell) is required by the monitor.
OCCLUSION?	Possible occlusion detected in CO_2 sampling tubing set.
PUT CO_2 SENSOR ON REFERENCE CELL	A cell zero was just completed by the monitor and the calibration needs to be verified. Place the CAPNOSTAT CO_2 sensor on the reference cell (marked REF or ✓CO_2) located on the sensor cable.
PUT CO_2 SENSOR ON ADAPTER IN ROOM AIR OK: △ CANCEL: ▽	User has requested to zero the CAPNOSTAT CO_2 sensor to the airway adapter, or this procedure is required by the monitor.
REMOVE FROM CELL AND PUT ON AIRWAY ADAPTER	Remove the CAPNOSTAT CO_2 sensor from the reference or zero cell and place on the airway adapter that is to be used.
SAMPLING LEAK?	Possible leak detected in CO_2 sampling tubing set.
SENSOR ON CELL: CO_2 ZERO NOT REQUIRED AT THIS TIME	CAPNOSTAT CO_2 sensor is currently on zero cell but the monitor does not require a zero at this time.
WRONG SENSOR	An incompatible CO_2 sensor is detected.
ZERO ERROR CHANGE SENSOR OR CALL SERVICE	The monitor was not able to perform the required zero operation. After five seconds, the appropriate message returns for retrying the zero operation. If it fails again, the appropriate sensor error will be displayed.

Message	**Meaning of message**
ZEROING CO_2 ON AIRWAY ADAPT: XX	An airway adapter zero is in progress. XX indicates the number of seconds remaining.
ZEROING CO_2 ON -0- CELL: XX	CAPNOSTAT CO_2 sensor is currently attached to the zero cell, and a “cell zero” is in progress.
ZEROING CO_2 ON CANNULA	Performing a zero operation with the nasal cannula attached.
ZERO ERROR	A zero error has occurred.
ZERO ON CANNULA	A cannula zero is required by the monitor. This would be displayed while using the sampling adapter with cannula.

Battery Status and Alerts

The LED on the front panel flashes when the battery is extremely low; this will be accompanied by an audible alert. When this occurs connect the power cord to the monitor's rear panel power entry module, set the rear panel power switch to "|" (ON), then connect to an AC power source. Verify that the front panel AC icon illuminates green.



Alerts

$ETCO_2$, respiratory rate, SpO_2 and pulse rate have both high and low alert settings that, when violated, generate audible and visual alerts. In all cases, the audible alert tone may be silenced for two minutes by pressing and releasing the ALERT SILENCE key (the 2 minute silence icon will illuminate). The audible alert tone may also be silenced for 2 minutes in advance of an anticipated alert, such as during suctioning, by pressing and releasing the ALERT SILENCE key (the 2 minute silence icon will illuminate).

The audible alert tone may be silenced permanently by pressing and holding the ALERT SILENCE key (the audio off icon will illuminate and flash) as long as the ALLOW AUDIO OFF setting is set to YES. (Factory default setting is "NO.") If the ALLOW AUDIO OFF is set to NO, the audible alert tone may not be silenced. In addition to audible alerts, several visual indicators are generated for parameter violations: the red ALERT BAR will flash and a flashing up or down arrow will appear next to the violated parameter that denotes whether a high or low violation occurred.

Standby States

A standby state is indicated by dashes in place of numeric values for a particular parameter. This will occur when the monitor is first turned on and before any valid patient data is obtained. When monitoring, if valid data is received then lost for $ETCO_2$, respiratory rate, SpO_2, or pulse rate, an alert condition will occur. If the key is pressed, and valid data is still not available, the numeric value of the parameter in question will display "--". If the key is not pressed within 30 seconds after the loss of data, the display will automatically turn to "--".

Setting Alert Limits

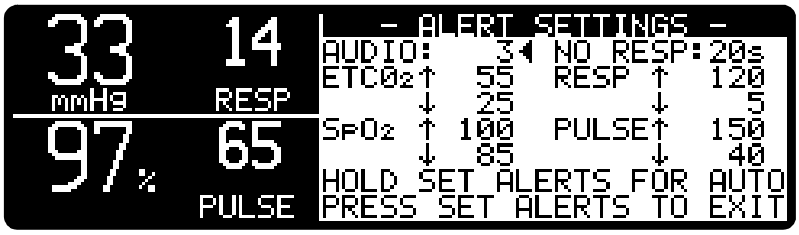
The alert limits for the monitor can be manually or automatically adjusted. When the monitor is turned off the alert limit settings will be retained, even if AC power and the battery are disconnected. The monitor can be configured to power up with the default limit values by setting the RETAIN LIMITS option in the CONFIGURATION menu to NO. The default settings can also be set while the monitor is on and displaying the ALERT SETTINGS screen by pressing and holding the SET ALERTS key.

Manually Setting Alert Limits

Press the SET ALERTS key to display the ALERT SETTINGS screen. Use the menu control keys to adjust the settings as desired: Press NEXT to move the arrow pointer to the desired parameter for adjusting. Use the △ and ▽ keys to change the selected value.

The RESP and PULSE high and low alert settings may be set independently, for example the HIGH RESP rate may be set to OFF, with a LOW limit set. When a limit is off, high or low for either parameter, a bell with a slash appears next to the corresponding parameter. The bell will appear at the top of the parameter or the bottom of the parameter depending on which limit is off.

SET ALERTS



Auto Alert Limits

Press and hold the SET ALERTS key for two seconds, and the monitor will automatically set alert limits based on recent patient data. The ALERT SETTINGS screen will appear with an “AUTO ALERT LIMITS SET” message. After a few seconds the display will return to the previous screen. If auto alert limits cannot be determined, the message “NOT ENOUGH DATA TO SET LIMITS” will appear.

Alert Latching

Latched alerts will continue to visually indicate that an alert occurred even when the alert condition is no longer present. The alert bar and the up/down indicator arrow for the exceeded limit will flash (audio does not remain on during a latched alert). This will continue until the key is pressed to reset the alert (In this condition pressing does not affect the 2 minute silence). Alerts are latched when the ALERT LATCH in the CONFIGURATION screen is set to ON.

Setting the ALERT LATCH to OFF in the CONFIGURATION screen will result in having an alert condition reset itself when the condition no longer exists. The factory default setting for ALERT LATCH is OFF.

Alert Audio

An audible alert is generated any time an alert condition is detected provided that neither the 2 minute silence, nor the audible alert muting are enabled. When the ALERT DELAY in the CONFIGURATION menu is set to ON there is a 10 second delay before the audible alert is generated from the time the alert is detected. This is to minimize nuisance alerts. If the ALERT DELAY is set to OFF then audible alerts are generated immediately.

Press the key to silence an audible alert for 2 minutes. Press again to cancel.

Press and hold the key to disable audible alerts. Press and hold again to cancel. The monitor will always power up with audible alerts enabled.

The audible alert volume can be adjusted from the SET ALERTS menu. It is the first item when this screen is displayed; therefore, simply press the △ and ▽ when the screen appears.

NOTE

Make sure that the audible alert volume is not set too low to be heard over ambient noise levels.

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Section 8 Maintenance

Cleaning and Sterilization

Follow the cleaning and sterilization instructions listed below to clean and/or sterilize the monitor and its accessories.

Monitor

- Turn the monitor off and unplug the line cord from the AC power source before cleaning.
- The monitor can be cleaned and disinfected with solutions such as a 70% isopropyl alcohol, 2% glutheralhyde, or 10% bleach solution. Then wipe down with a water dampened clean cloth to rinse. Dry before use.
- Do not immerse the monitor.
- Do not attempt to sterilize the monitor.

SpO_2 Finger Sensor

- The sensor can be cleaned and disinfected with solutions such as a 70% isopropyl alcohol, 2% glutheralhyde, or 10% bleach solution. Then wipe down with a water dampened clean cloth to rinse. Dry before use.
- Make certain that the finger sensor windows are clean and dry before reuse.
- Do not immerse the finger sensor.
- Do not attempt to sterilize the finger sensor.
- After cleaning the finger sensor, verify that the sensor is physically intact, with no broken or frayed wires or damaged parts. Make certain that the connectors are clean and dry, with no signs of contamination or corrosion. Do not use a broken or damaged sensor or one with wet, contaminated or corroded connectors.
- Perform a “Quick Check” to verify the integrity of the sensor (See “Finger Sensor Quick Check” on page 35).

SpO_2 Y-Sensor

- Do not immerse connector on the Y-Sensor.
- The Y-Sensor may be immersed—up to, but not including, the connector, in a 2% glutheralhyde solution, or 10% bleach solution. Refer to manufacturer’s instructions and standard hospital protocols to determine recommended times for disinfection and sterilization.
- Rinse thoroughly with water and dry before use (do not rinse the connector).
- Do not attempt to sterilize Y-Sensor except as stated above.

- After cleaning or sterilizing the Y-Sensor, verify that the sensor is physically intact, with no broken or frayed wires or damaged parts. Make certain that the connectors are clean and dry, with no signs of contamination or corrosion. Do not use a broken or damaged sensor or one with wet, contaminated, or corroded connectors.
- Perform a "Quick Check" to verify the integrity of the sensor (See "Y-Sensor Quick Check" on page 41).

SpO_2 Y-Strip Tapes and Foam Wraps

- Treat Y-Strip Tapes and foam wraps in accordance with hospital protocol for single-patient use items.

Ear Clip

- Do not immerse the ear clip
- Clean the ear clip with a cloth dampened with 70% isopropyl alcohol. After cleaning wipe the ear clip down thoroughly with a clean water dampened cloth to rinse.

Flow Sensors and Combined CO_2/Flow Sensors

- Treat all flow and CO_2/flow sensors in accordance with hospital protocol for single-patient use items.

CAPNOSTAT CO_2 Sensor

- Clean the sensor surface with a damp cloth.
- Make certain that the sensor windows are clean and dry.
- Do not immerse the CAPNOSTAT CO_2 sensor.
- Do not attempt to sterilize the CAPNOSTAT CO_2 sensor.

Reusable Adult Airway Adapter

- The Adult Airway Adapter (Cat. No. 7007) may be cleaned by rinsing in a warm soapy solution, followed by soaking in a liquid disinfectant, pasteurized, or sterilized by soaking in glutaraldehyde. It should then be rinsed with sterile water and dried.
- The Adult Airway Adapter (Cat. No. 7007) may be sterilized using either steam autoclave or ETO (ethylene oxide) gas methods. Be sure to use appropriate aeration times.
- Before reusing the adapter, ensure that the windows are dry and residue-free, and that the adapter has not been damaged during handling or by the cleaning/sterilization process.

Reusable Neonatal Airway Adapter

- The Neonatal Airway Adapter (Cat. No. 7053) may be cleaned by rinsing in a warm soapy solution, followed by soaking in a liquid disinfectant, pasteurized, or sterilized by soaking in glutaraldehyde. It should then be rinsed with sterile water and dried.

- The Neonatal Airway Adapter (Cat. No. 7053) may be sterilized using ETO (ethylene oxide) gas. Be sure to use appropriate aeration times.
- Before reusing the adapter, ensure that the windows are dry and residue-free, and that the adapter has not been damaged during handling or by the cleaning/sterilization process.

External Sampling System Components

- The Nasal Sampling Cannulas are for single-patient use.
- The Sampling Adapter with tubing (Cat. No. 5843) may be cleaned by rinsing in a warm soapy solution, followed by soaking in a liquid disinfectant. It should then be rinsed with sterile water and dried.

Single Patient Use Airway Adapters

- Treat all single patient use airway adapters in accordance with hospital protocol for single-patient use items.

Internal Sampling System Components

Acceptable fluids for cleaning and sterilizing the internal pneumatic parts of the Sampling System include isopropyl alcohol, Cidex[1] or equivalent, or a 5.25% water solution by weight of sodium hypochlorite (bleach).

CAUTION

Do not attempt to pump cleaning/sterilizing liquid with the sampling pump. This may cause accelerated wear on the pump bearings. Always flush liquids with a syringe as described in the following instructions.

To clean and disinfect the pumping system:

1. Turn the monitor off and disconnect the AC line cord.
2. Remove both the sampling inlet tubing set and the sampling exhaust tubing (if any).
3. Attach an exhaust port line (1/8 inch or 3/16 inch I.D. tubing) from the Sampling Exhaust port to a suitable container located below the bottom level of the monitor.
4. Use a 60 cc catheter tip syringe. Fit it to the SAMPLING SYSTEM INLET connector. Flush the sterilizing solution slowly through the pumping system. Push the entire 60 cc of solution through the SAMPLING INLET. Repeat this process two more times to use a total of 180 cc of solution.
5. Remove the syringe and leave the cleaning/sterilizing fluid within the sampling pump system for 30 minutes to disinfect the system. Follow sterilant manufacturer's instructions for disinfection.
6. After 30 minutes, fill the syringe with distilled water and flush the system three times. Allow the cleaning/disinfection solution and distilled water to drain through the SAMPLING EXHAUST output.
7. Push several syringes of air slowly through the system to ensure that most of the liquid has been drained.

1. Cidex is a trademark of Arbook, Inc.

8. Follow this with at least three more syringes of distilled water, followed by at least two more syringes of air to make sure that most of the distilled water has been drained.
9. Remove the syringe from the unit. Do not connect the sampling inlet tubing. Connect the AC line cord and turn the monitor on. Allow the sampling pump to operate for several minutes. This will help to remove any trapped water.
10. Connect a sampling tubing set to the SAMPLING SYSTEM INLET.
11. Block the open end of the tubing with your finger. Alternate blocking and unblocking the tubing end at least ten times. Use a quick, brisk motion when blocking and unblocking the tubing. Keep the tubing blocked and unblocked for several seconds at a time.
12. Repeat the same blocking and unblocking action with your finger on the sampling exhaust port.
13. Allow the sampling system to run for at least 30 minutes without the sampling assembly tubing and the sampling exhaust tubing connected. This will speed dry the system pneumatics.
14. Once these cleaning and disinfection instructions have been completed, normal sampling system operation can be resumed. See "Sampling Airway Adapter."

Maintenance Schedules

When the monitor powers up a self test is performed which checks the internal electronics of the monitor. If this self test fails, remove the monitor from use and contact qualified service personnel.

The monitor should undergo routine inspection and safety checks on a quarterly basis or according to hospital protocol. The *CO_2SMO Plus!* Service Manual (Catalog No. 6758-90) contains procedures and safety test instructions, component parts lists, circuit diagrams, theory of operation and other information to assist qualified service personnel in servicing the monitor.

Battery Maintenance

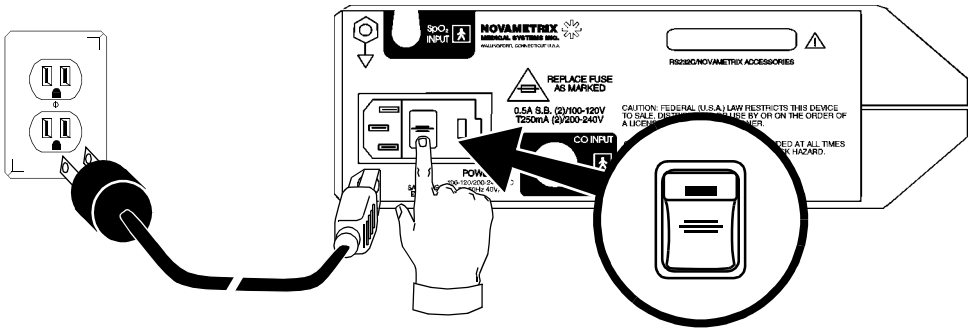
If the monitor has not been used or powered by AC mains for an extended time[2] (3 months or more) allow the battery to charge for 12 hours before use. The monitor may not power up on battery power if the battery is not sufficiently charged. Allow the battery to charge for 12 hours before initial use, refer to the following diagram for charging instructions.

NOTE

When the battery is low (blinking on front panel) the monitor will not zero the flow sensor. This may cause the calculations based on the flow signal to drift outside of normal performance specifications. Connect to AC power as soon as possible.

2. The internal battery may slowly discharge over long periods of non-use.

To charge the battery, connect the line cord to an AC source and set the rear panel power switch ON (|). Check that the front panel ∿ icon is green. Charge the battery for 12 hours.



If the battery requires replacement refer to the *CO_2SMO Plus!* Service Manual (Catalog No. 6758-90) for instructions. Have this procedure performed by qualified service personnel only, there are no user serviceable parts inside the monitor.

Mains Voltage Configuration

The rear panel power entry module indicates the mains voltage setting for the monitor. Check that the voltage is correct before attaching the AC line cord and powering the monitor. The *CO_2SMO Plus!* can be set to operate from 100-120 VAC 50/60Hz or 200-240VAC 50/60Hz.

Instructions for fuse replacement and changing the mains voltage setting follow.

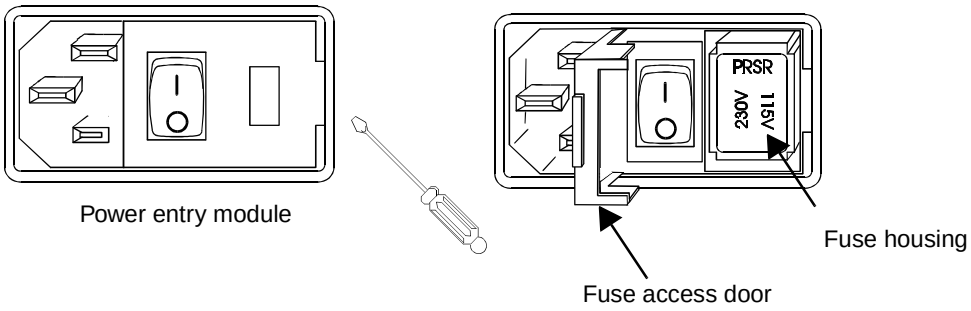
CAUTION

Replace fuses with same type and rating. Verify proper fuse value for mains voltage setting (see table below).

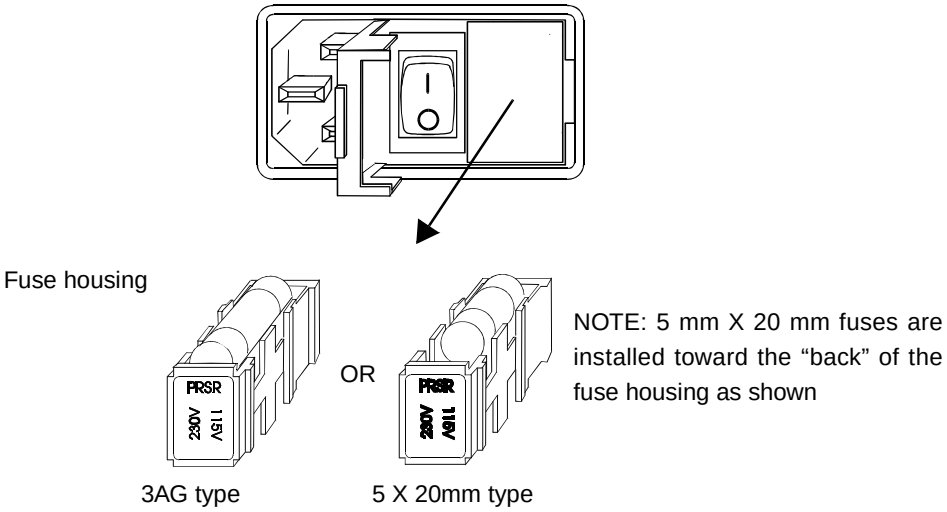
Fuse Replacement

1. Check that the monitor is OFF.
2. Set the rear panel power entry module switch to OFF (“O”). Remove the AC line cord from the power entry module.
3. Using a flat blade screwdriver, pry the fuse access door open to expose the fuse housing. Note the orientation of the fuse housing (this determines the mains operating voltage).

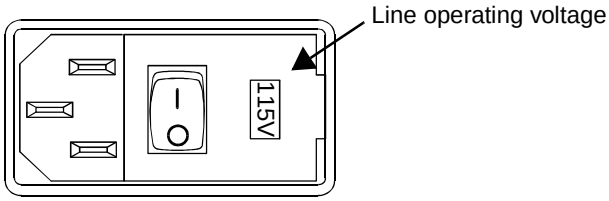
Mains Voltage	Fuses (Slo Blo)
100-120 Vac	0.5 A 250V
200-240 Vac	250mA 250V



4. Pry the fuse housing out from the power entry module.



5. Replace the blown fuse(s) with the proper type and rating.
6. Reinstall the fuse housing. When positioning the housing into the power entry module make sure that it is oriented correctly. Press the fuse housing back into the power entry module.
7. Close the fuse access door and verify that the proper mains operating voltage is displayed.



Changing the Mains Voltage Setting

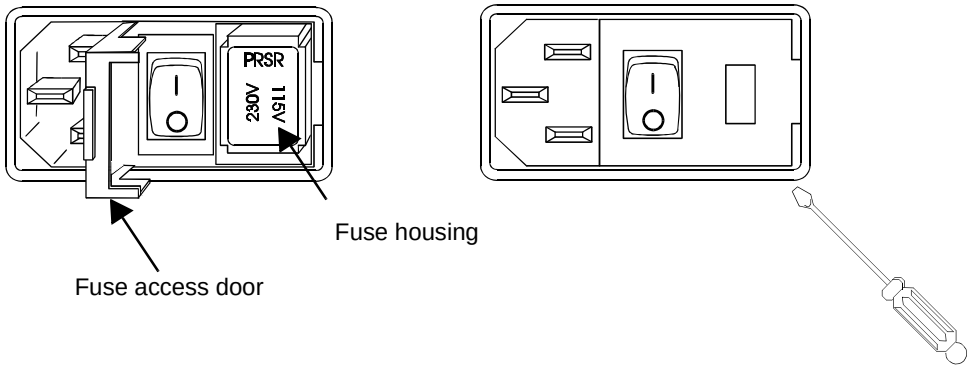
1. Check that the monitor is OFF.
2. Set the rear panel power entry module switch to OFF (“O”). Remove the line cord from the power entry module.

CAUTION

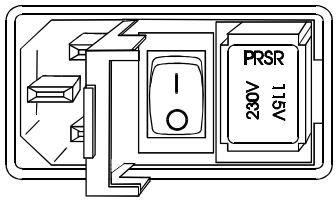
Replace fuses with same type and rating. Verify proper fuse value for mains voltage setting (see table below).

Mains Voltage	Fuses (Slo Blo)
100-120 Vac	0.5 A 250V
200-240 Vac	250mA 250V

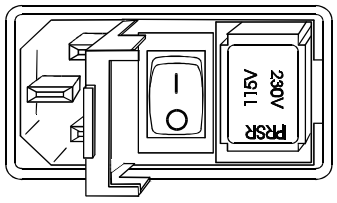
3. Using a flat blade screwdriver, pry the fuse access door open to expose the fuse housing. Pry the fuse housing out from the power entry module.



4. Install the proper type and rating fuse for the mains voltage setting required.
5. Position the housing into the power entry module so that the desired voltage is furthest away from the switch (see below).

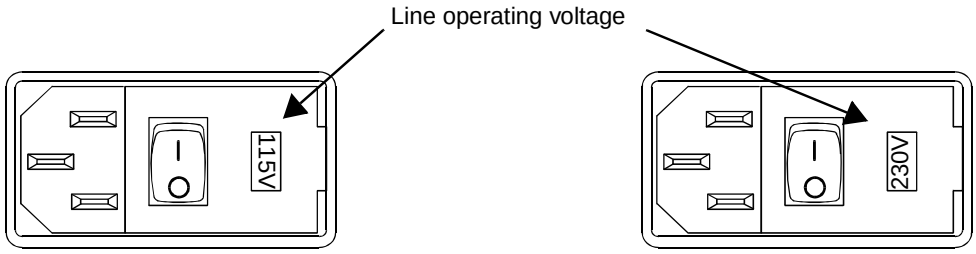


Set for 100-120V operation



Set for 200-240V Operation

6. Close the fuse access door and verify that the proper mains operating voltage is displayed.



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Section 9 Specifications

General

Specifications for the Novametrix *CO_2SMO Plus!* Monitor, Model 8100, are listed for informational purposes only, and are subject to change without notice.

Capnograph

- Principle of Operation: Non-Dispersive Infrared (NDIR) absorption, dual wavelength ratiometric-single beam optics
- Sensor Type: "Mainstream" (no gas sample drawn from breathing circuit)
- Initialization Time: Capnogram in 15 seconds, full specifications in 60 seconds.
- Response Time: Less than 75 ms
- O_2/N_2O Heliox, O_2 > 60%, Anesthetic Agent Compensation: Operator selectable
- Barometric Pressure Compensation: Automatic (range 400-800 mmHg)
- CAPNOSTAT CO_2 Sensor and Airway Adapter:
  Weight: Less than 2 oz. (57 g) without cable
  Sensor Size: 1 3/4 x 1 1/2 x 3/4 inches (4.45 x 3.81 x 1.91 cm), 8 foot cable (2.44 m)
  Construction: Durable high performance plastic, ultra-flexible cable
  Shock Resistant: Sensor will withstand a 6 foot drop to a tile floor
- Airway Adapter: Single Patient Use or reusable, less than 5 cc deadspace, meets ANSI Z-79
- End Tidal CO_2:
  Range: 0-100 mmHg, 0-12.5 Kpa or %
  Accuracy: ± 2 mmHg for 0-40 mmHg, ± 5% of reading for 41-70 mmHg, ± 8% of reading for 71-100 mmHg
  Display Resolution: 0-50 mmHg scale 0.9 mmHg, 0-75 mmHg scale 0.6 mmHg
- Respiratory Rate:
  Range: 0-150* breaths/min
  Accuracy: ± 1 breath/min

*Range 0-70 when used with sampling airway adapter.

Pulse Oximeter

- Oxygen Saturation
  Range: 0-100%
  Accuracy: ± 2% for 80-100%, unspecified for 0-79% (approximately 68% of the observations are within the accuracy claim)
  Display Resolution: 1%
  Averaging Time: Menu selectable 2 or 8 seconds
- Pulse Rate:
  Range: 30-250 beats per minute
  Accuracy: ± 1% of full scale (approximately 68% of the observations are within the accuracy claim)
  Display Resolution: 1 beat per minute
  Averaging Time: fixed at 8 seconds

Flow Sensor Specifications

- **Flow Range (L/min):**
  Neonatal Flow - 0.25 to 28
  Neonatal CO_2/Flow - 0.25 to 28
  Pediatric/Adult Flow - 2 to 180
  Pediatric/Adult CO_2/Flow - 2 to 180
- **Flow Accuracy:**
  Neonatal Flow - Greater of ± 3% reading or .125 L/min
  Neonatal CO_2 Flow - Greater of ± 3% reading or .125 L/min
  Pediatric/Adult Flow - Greater of ± 3% reading or .5 L/min
  Pediatric/Adult CO_2/Flow - Greater of ± 3% reading or .5 L/min
- **Minute Volume Range (L/min):**
  Neonatal Flow 0.1 to 15
  Neonatal CO_2/Flow 0.1 to 15
  Pediatric/Adult Flow 2 to 60
  Pediatric/Adult CO_2/Flow 2 to 60
- **Tidal Volume Range (ml):**
  Neonatal Flow - 1 to 500
  Neonatal CO_2/Flow - 1 to 500
  Pediatric/Adult Flow - 100 to 3000
  Pediatric/Adult CO_2/Flow - 100 to 3000
- **Airway Pressure Range (cm H_2O):**
  Neonatal Flow -120 to 120
  Neonatal CO_2/Flow -120 to 120
  Pediatric/Adult Flow -120 to 120
  Pediatric/Adult CO_2/Flow -120 to 120
- **Added Dead Space (ml):**
  Neonatal Flow - less than 1 ml
  Neonatal CO_2/Flow - less than 1 ml
  Pediatric/Adult Flow - 6.5
  Pediatric/Adult CO_2/Flow - 8

Monitor Specifications

- Classification (IEC601-1): Class I/internal power source, type BF, continuous operating mode
- Operating Environment: 50-104° F (10-40° C), 0-90% relative humidity (non-condensing)
- Size: Height 3.3 in. (8.38 cm), Width 9 in. (22.86 cm), Depth 8 in. (20.32 cm)
- Weight: 8 pounds (3.63 kg)
- Power: 100-120/200-240 Vac, 50-60 Hz, 40VA
- Fuse Rating: 100-120/200-240 VAC, 0.5 A 250 V Slo-Blo (x2); 200-240 VAC, T 250 mA/250 V (x2)
- Battery: Sealed lead-acid gel-cell, not externally removable, rechargeable, 2 hour life on full charge (on-screen life indicator), 12 hours recharge time, non-standard, 178mm x 34mm x 64mm (L x W x H).
- Display: 1.5 x 5 inch (3.81 x 12.7 cm) Cold Cathode Display (CCD)
- Electromagnetic Emissions: Conforms to EMC Directive 89/336/EEC, CISPR Class A. Tested to EN55011 (1991) and CISPR11 (1990).
- Electromagnetic Immunity: Conforms to EMC Directive 89/336/EEC, EN50082-1 (1992). Tested to IEC801-3 (1984) Radiated Immunity. Conforms to Medical Device Directive 93/42/EEC EN60601-1 (1992). Tested to IEC801-2 (1991) ESD, IEC801-4 (1988) EFT, and IEC1000-4-5 (1995) Surge Immunity.

Additional Features

- Audible SpO_2 Trend Feature: Pitch of Pulse Rate “beep” tracks the SpO_2 value, user selectable volume.
- Alert Limits: Automatic or menu selected high and low limits for $ETCO_2$, Respiratory Rate, SpO_2 and Pulse Rate. No respiration alert selectable between 20 and 60 seconds. Visible alert is immediate; audible alert can be delayed until 10 seconds after set limit is exceeded.
- 2-Minute Silence: When key is pressed, audible alerts are deactivated for two minutes. Indicated by illuminated (2 minute LED)
- Audio Off: Press and hold key for 3 seconds to deactivate audible alerts. Indicated by flashing (Audio Off LED)
- Trend Memory: 24 hour trend memory capacity, battery backed. On-screen trends for VCO_2, mechanical and spontaneous alveolar minute ventilation, mechanical and spontaneous alveolar tidal volume, and airway deadspace. Other parameters are stored internally and can be downloaded to a PC.
- Digital Data Output: Serial (RS232), connect only to IEC601 approved devices.
- Sampling System: Standard. Allows gas sampling of non-intubated patients
- Internal Real Time Clock
- Red Alert Bar

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Section 10 *Warranty*

Equipment manufactured or distributed by Novametrix Medical Systems Inc., is fully guaranteed, covering materials and workmanship, for a period of one year from the date of shipment, except for certain disposable products and products with stated guarantees other than one year. Novametrix reserves the right to perform guarantee service(s) at its factory, at an authorized repair station, or at the customer's installation.

Novametrix' obligations under this guarantee are limited to repairs, or at Novametrix' option, replacement of any defective parts of our equipment, except fuses, batteries, and calibration gasses, without charge, if said defects occur during normal service.

Claims for damages during shipment must be filed promptly with the transportation company. All correspondence concerning the equipment must specify both the model name and number, and the serial number as it appears on the equipment.

Improper use, mishandling, tampering with, or operation of the equipment without following specific operating instructions will void this guarantee and release Novametrix from any further guarantee obligations.

Service Department
For factory repair service, call toll free
1-800-243-3444
In Connecticut, call Collect (203) 265-7701
Facsimile (203) 284-0753
World Wide Web: http://www.novametrix.com
Internet: techline@novametrix.com

Caution: Federal (U.S.A.) law restricts this device to sale, distribution, or use by or on the order of a licensed medical practitioner.

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Service Policy

Novametrix Medical Systems Inc. will provide Warranty Service Support to its customers within 48 hours of receiving a telephone request for technical support. This 48 hour period begins once a service request is placed through the Factory Technical Support Department in Wallingford, Connecticut. Novametrix provides factory direct technical support to its customers through a technical support group located in Wallingford, Connecticut and company service representatives located throughout the United States. All Technical Support for Novametrix products is provided "Factory Direct."

Novametrix provides 24 hour a day technical support accessibility via telephone numbers (800) 243-3444 or (203) 265-7701. After hours technical support requests (before 8:00 AM and after 5:00 PM Eastern Time) will be responded to promptly by the Technical Support On-Call staff. It is suggested that any person calling in for technical support have the inoperative equipment available for preliminary troubleshooting as well as product identification. Novametrix reserves the right to repair or replace any product found to be defective during the warranty period. Repair may be provided in the form of replacement exchange parts or accessories, on-site technical repair assistance or complete system exchanges. Repairs provided due to product abuse or misuse will be considered "non-warranty" and invoiced at the prevailing service rate. Any replaced defective material is expected to be returned to Novametrix within 10 days of being provided in order to avoid additional charges. Exchanged material should be returned promptly and directly to Novametrix using the return paperwork and shipping label(s) provided. Transferring return materials to local sales or dealer representatives does not absolve return responsibility.

Novametrix manufactures equipment that is generally "user serviceable" and can usually be repaired with the replacement of a plug-in electro-mechanical assembly by the clinical end user. When repair parts are provided, the recipient can call into Novametrix for on-line replacement assistance and repair assurance. In the event a replacement part requires increased technical capability, Technical Support may request Biomedical assistance, provide on-site technical support or complete replacement equipment. If the customer requires the return of their original product, the exchange material will be considered "loaner material" and exchanged again after the customer equipment is repaired.

Novametrix promotes customer participation in warranty repairs should they become necessary. This program allows for customer training and a smooth transition into self-maintenance after warranty, which can provide substantial cost savings on repairs throughout the product's life.

The Novametrix Technical Support Department can provide technical product support at a level appropriate to most customers protocol and budget requirements. Please contact the Technical Support Group at Novametrix for additional information.

Additional Novametrix Technical Support Programs:

- Focus Series Technical Training Seminars
- Test Equipment and Test Kits
- Service Contract / Part Insurance Plans
- On-Site Technical Support
- 24 hr. telephone support
- "Demand Services"
  - Flat rate parts exchange
  - Flat rate return for repair
  - Time and material,
  - Full warranty, discounted replacement sensors.

Section 11 *Accessories*

CO_2SMO Plus! (Model 8100) Respiratory Profile Monitor

Catalog No.	Description
6758-00	*CO_2SMO Plus!* **Respiratory Profile Monitor (Model 8100)** with CAPNOSTAT CO_2 Sensor (Cat. No. 7167), Oxy*Snap* SuperBright finger sensor (Cat. No. 8744), and one each pediatric/adult and neonatal combined CO_2/flow sensor.

CAPNOSTAT MAINSTREAM CO_2 SENSOR and ACCESSORIES

7167-00	**CAPNOSTAT CO_2 Sensor** with Adult Airway Adapter (Cat. No. 7007) and (5 ea.) Sensor Cable Holding Clips (Cat. No. 8751)
8751-00	**CAPNOSTAT CO_2 Sensor Cable Holding Clips** (50 per box)

COMBINED CO_2/FLOW SENSORS (SINGLE PATIENT USE)

The following are airway adapters (for the CAPNOSTAT CO_2 sensor) combined with a flow sensor.

6719-00	***Series 3*** **Pediatric/Adult Combined CO_2/Flow Sensor** (10 per box)
6720-00	***Series 3*** **Neonatal/Pediatric Combined CO_2/Flow Sensor** (10 per box)

CO_2 AIRWAY ADAPTERS (REUSABLE)

For monitoring CO_2 with the CAPNOSTAT CO_2 sensor. (Also available in lower quantities)

7007-00	**Pediatric/Adult Airway Adapters** (10 per box)
7053-00	**Neonatal/Pediatric Airway Adapters** (10 per box)

CO_2 AIRWAY ADAPTERS (SINGLE PATIENT USE)

For monitoring CO_2 with the CAPNOSTAT sensor.

6063-00	**Pediatric/Adult Single Patient Use Airway Adapters** (10 per box)
6063-25	**Pediatric/Adult Single Patient Use Airway Adapters** (25 per box)
6421-00	**Pediatric/Adult Single Patient Use Airway Adapters with mouthpiece** (10 per box)
6421-25	**Pediatric/Adult Single Patient Use Airway Adapters with mouthpiece** (25 per box)
6312-00	**Neonatal/Pediatric Single Patient Use Airway Adapters** (10 per box)
6312-25	**Neonatal/Pediatric Single Patient Use Airway Adapters** (25 per box)

SAMPLING ADAPTER and ACCESSORIES

5843-00	**Sampling Adapters with tubing** (10 per box)
8908-00	**Nafion® Dehumidification Tubing** (10 per box)
8781-00	**Nasal CO_2 Sampling Cannula—Adult** (10 per box)
8780-00	**Nasal CO_2 Sampling Cannula—Pediatric** (10 per box)
8906-00	**Nasal CO_2 Sampling and O_2 Delivery Cannula—Adult** (10 per box)
8907-00	**Nasal CO_2 Sampling and O_2 Delivery Cannula—Pediatric** (10/box)
8909-00	**Sidestream Monitoring Kit for Pediatric Tracheostomy Patients** (10 per box)

Catalog No.	Description

FLOW SENSORS

For monitoring airway flow without an adapter for the CAPNOSTAT CO_2 sensor.

6717-00	***Series 3*** **Pediatric/Adult Flow Sensor** (10 per box)
6718-00	***Series 3*** **Neonatal Flow Sensor** (10 per box)

SpO_2 SENSORS and ACCESSORIES

REUSABLE Oxy*Snap*™ SpO_2 SENSORS AND CABLES

8793-00	**Oxy*Snap* Y-Sensor** (use with **Oxy*Snap*** Extension Cable)
8744-00	**Oxy*Snap* Finger Sensor** (use with **Oxy*Snap*** Extension Cable)
8853-00	**Oxy*Snap* Extension Cable**, 8 ft. (use with **Oxy*Snap*** sensors)
8898-00	**Oxy*Snap* Long Extension Cable**, 12 ft. (use with **Oxy*Snap*** sensors)

OTHER SpO_2 SENSORS

8776-00	**SuperBright™ Finger Sensor** (10 ft. sensor cable)
8791-00	**SuperBright™ Y-Sensor** (10 ft. sensor cable)
8789-00	**Special Use SuperBright™ Finger Sensor** (8 inch sensor cable)
5238-00	**Special Use SuperBright™ Finger Sensor** & 25 ft. shielded cable

Y-STRIP TAPES, FOAM WRAPS and EAR CLIPS (for use with the Y-Sensor)

8828-00	**20mm Wrap Style Y-Strip Taping System** (100 per box) Use on neonatal foot and hand, or on pediatric toe or finger 20mm tapes use Blue color coded liners
8829-00	**25mm Wrap Style Y-Strip Taping System** (100 per box) Use on neonatal foot and hand 25mm tapes use Green color coded liners
8831-00	**20mm Finger Style Y-Strip Taping System** (100 per box) Use on pediatric finger or on small adult finger 20mm tapes use Blue color coded liners
8832-00	**25mm Finger Style Y-Strip Taping System** (100 per box) Use on adult finger 25mm tapes use Green color coded liners
8836-00	**Non-Adhesive Foam Wraps** (25 per box) For use with Y-Sensor
8943-00	**Neonatal/Pediatric Non-Adhesive Foam Wraps** (25 per box)) For use with Y-Sensor
6131-50	**Ear Clips** For use with Y-Sensor (5 per box)
6131-25	**Ear Clips** For use with Y-Sensor (25 per box)

EXTENSION CABLES FOR SpO_2 SENSORS (with Hypertronics connector)

4941-00	**Saturation Sensor Extension Cable**— 4 feet
4942-00	**Saturation Sensor Extension Cable**— 6 feet
4943-00	**Saturation Sensor Extension Cable**—10 feet
5266-00	**Saturation Sensor Extension Cable**—25 feet

SINGLE PATIENT USE SpO_2 SENSORS AND CABLES

6455-00	**Pediatric/Adult Single Patient Use SpO_2 Sensor** Terminates in DB9 connector (10 per box)

Catalog No.	Description
6455-25	**Pediatric/Adult Single Patient Use SpO_2 Sensor** Terminates in DB9 connector (25 per box)
6480-00	**Neonatal/Pediatric Single Patient Use SpO_2 Sensor** Terminates in DB9 connector (10 per box)
6480-25	**Neonatal/Pediatric Single Patient Use SpO_2 Sensor** Terminates in DB9 connector (25 per box)
8933-00	**DB9 Extension Cable** For use with Single Patient Use sensor above
8936-00	**DB9/OxySnap Connector cable** Use to connect Single Patient Use sensors to OxySnap connector

MISCELLANEOUS

7104-10	**Side Pouch** for accessories (included with monitor)
600026	**Power Cord** (included with monitor)
5334-00	**Cable** Serial Output to Personal Computer (with 25-pin connector)
5335-00	**Cable** Serial Output to Personal Computer (with 9-pin connector)
6758-90	**Service Manual** *CO_2SMO Plus*! (Model 8100) Respiratory Profile Monitor

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